SCIENCE-IX

MODULE - 2

INDEX

S.N.	TOPIC	PAGE NO.
1.	Atoms and Molecules	1 - 26
2.	Structure of Atoms	27 - 57

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ATOMS AND MOLECULES

INTRODUCTION

The structure of matter has been a subject of speculation from very early times. According to greek philosopher Aemocritus, if we go on dividing matter into smaller parts, a stage would be reached when particles obtained cannot be divided further. He called these particles 'atoms' meaning indivisible.

Conclusion : All matter is made up of small particles called atoms. Different kinds of atoms and molecules have different properties due to which different kinds of matter also show different properties.

LAWS OF CHEMICAL COMBINATION

By studying the result of quantitative measurement of many reactions it was observed that whenever substances react, they follow certain laws. These laws are called the law of chemical combination.

(a) Law of conservation of mass. (b) Law of constant proportions.

(c) Law of multiple proportions.

(a) Law of conservation of mass ;

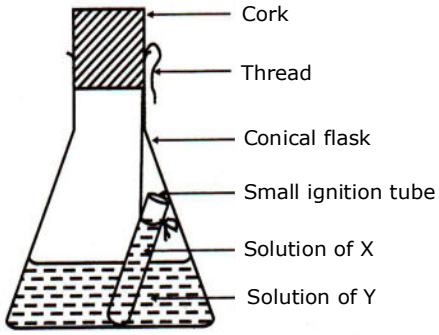
This law was given by the french chemist **A. Lavoisier in** 1774. This law states that in every chemical reaction, the total mass before and after the reaction remains constant.

"That is mass can neither be created nor destroyed in a chemical reaction". Lavoisier showed that when mercuric oxide was heated, it produced free mercury and oxygen. The sum of masses of mercury and oxygen was found to be equal to the mass of mercuric oxide.

Mercuric oxide $\rightarrow$	**Mercury**	**+**	**Oxygen**
100 g	92.69 g		7.49 g

Activity : Demonstration of law of conservation of mass.

- Prepare separately a 5% solution of barium chloride and a 5% solution of sodium sulphate.
- Take about 20ml of barium chloride solution in a conical flask.
- Take sodium sulphate solution in a small test tube. Hang the test tube in the conical flask with the help of a thread. Close the mouth of the flask with cork.
- Weigh the flask along with its contents.
- Now tilt the flask so that the two solution get mixed.



Ignition tube containing solution of X, dipped in a conical flask containing solution of Y.

- Weigh the flask again along with its contents. What do you observe ? It is observed that on mixing the two solution a chemical reaction takes place which is indicated by the formation of a white precipitate

Barium chloride + Sodium sulphate $\rightarrow$ Barium sulphate (white ppt) + Sodium Chloride

- The mass of the flask and its contents remains constant. Thus, during a chemical reaction mass is neither created nor destroyed.

This activity can also be carried out with the following pairs :

(a) Silver nitrate and sodium chloride (b) Copper sulphate and sodium carbonate

Q. In a reaction 5.3 g of sodium carbonate reacted with 6 g of ethanoic acid. The products were 2.2 g of carbon dioxide. 0.9 g water and 8.2 g of sodium ethanoate. Show that these observations are in agreement with the law of conservation of mass. **[NCERT]**

Sodium carbonate + ethanoic acid $\rightarrow$ sodium ethanoate + carbon dioxide + water.

Q. Hydrogen and oxygen combine in the ratio of 1 : 8 by mass to form water. What mass of oxygen gas would be required to react completely with 3 g of hydrogen gas? **[NCERT]**

Q. Which postulate of Dalton's atomic theory is the result of the law of conservation of mass? **[NCERT]**

(b) Law of constant Proportions / Law of definite proportions :

This law was given by the french chemist **A. Lavoisier and Joseph Proust.** This law deals with the composition of chemical compounds.

This law is : ***A pure chemical compound always contains same elements combined together in same proportion by mass.***

For example : Pure water obtained from different sources such as river, well etc. always contains hydrogen and oxygen combined together in the ratio 1 : 8 by mass similarly carbon dioxide can be obtained by different methods such as by burning of carbon, by heating lime stone. It shows that samples of carbon dioxide obtained from different sources contain carbon and oxygen in the ratio of 3 : 8 by mass. Thus in water or CO_2 this proportion of hydrogen and oxygen or carbon and oxygen always remains constant.

Ex. Hydrogen and oxygen combine in the ratio of 1 : 8 by mass to form water. What weight of oxygen gas would be required to completely react with 3 g of hydrogen gas.

Sol. Ratio in which hydrogen and oxygen combine = 1 : 8

1 g of hydrogen combines with oxygen = 8 g

$\therefore$ 3 g of hydrogen will combine with oxygen = $8 \times 3 = 24$ g.

(c) Law of multiple proportions :

It was given by Dalton in 1808. According to it, when one element combines with the other element to from two or more different compounds, the mass of one element, which combines with a constant mass of the other, bear a simple ratio to one another. Example : Carbon and oxygen when combine, can from two oxides that are CO (carbon monoxide), CO_2 (carbon dioxide).

In CO, 12g carbon combine with 16g of oxygen. In CO_2, 12g carbon combine with 32g of oxygen. Thus, we can see the mass of oxygen which combine with a constant mass of carbon (12g) bear simple ratio of 16 : 32 or 1 : 2.

DALTON'S ATOMIC THEORY

On the basis of laws of chemical combination John Dalton proposed atomic theory in 1808. The main points of dalton's atomic theory are :

The main postulates of the Dalton's atomic theory are :

1. All matter is made up of very tiny particles called atoms.

2. Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction,

3. Atoms of a given element are identical in mass size and chemical properties.

4. Atoms of different element have different mass size and chemical properties.

5. Atoms combine in the ratio of small whole numbers to form compounds.

6. The relative number and kinds of atoms are constant in a given compound.

Dalton's atomic theory was based on the laws of chemical combination.

7. Atoms of same element can combine in more than one ratio to form more than one compound. For example, hydrogen and oxygen combine to give water and hydrogen peroxide. In water, two atoms of hydrogen combine with one atom of oxygen while in hydrogen peroxide, two atoms of hydrogen combine with two atoms of oxygen.

For example : The postulates of Dalton's *atomic theory that "atoms can neither be created nor destroyed",* was the result of law of conservation of mass and the postulates of Dalton's atomic theory that *"the element consist of atom having fixed mass"*, and that the number and kind of atom in a given compound is fixed came from the law of constant proportions.

Q. Which postulate of Dalton's atomic theory can explain the law of definite proportions? **[NCERT]**

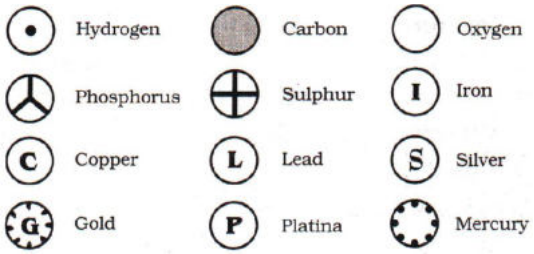
Drawbacks of Dalton's Atomic Theory :

Some of the drawbacks of the Dalton's atomic theory of matter are given below :

- According to Dalton's atomic theory, atoms were thought to be indivisible. But it is now known that atoms can be further divided into still smaller particle called electrons, protons and neutrons.
- Dalton's atomic theory said that all the atoms of an element have exactly the same mass. But it is now known that atoms of the same element can have slightly different masses, as in case of isotopes.
- Dalton's atomic theory said that atoms of different elements have different masses. But it is now known that even atoms of different elements can have the same mass as in case of isobars.

ATOMS

All the matter is made up of atoms. An atom is the smallest particles of an element that can take part in a chemical reaction. Atoms of most of the elements are very reactive and do not exist in the free state (as single atom). They exist in combination with the atoms of the same elements or another element. Atoms are very small in size. The size of an atom is indicated by its radius which is called atomic radius (radius of an atom). Atomic radius is measured in nanometre (nm) (1 metre = 10^9 nanometres or 1nm = 10^{-9}m). Hydrogen atoms is the smallest atom of all, having an atomic radius of 0.037nm. Atoms are so small that we cannot see them under the most powerful optical microscope.



Symbols for some elements as proposed by Dalton

Symbol of elements :

Symbol may be defined as the abbreviation used for the name of an element. The symbol of an element are generally either the first letter or the first two letters or the first and the third letters of the name of the element. for example, the symbol of the following elements are the first letter of the name of that element.

S.No.	Element	Symbol
1	Hydrogen	H
2	Carbon	C
3	Nitrogen	N
4	Oxygen	O
5	Fluorine	F

- Some symbols derived from the first two letters of the names of the element.

S.No.	Element	Symbol
1	Aluminium	Al
2	Barium	Ba
3	Lithium	Li
4	Neon	Ne
5	Calcium	Ca

- Some symbol derived from the first and the third letter of the names of the elements.

S.No.	Element	Symbol
1	Arsenic	As
2	Magnesium	Mg
3	Chlorine	Cl
4	Zinc	Zn
5	Chromium	Cr

- There are certain symbols which seen to here no relationship to their names. The symbol of these elements are derived from their latin names.

Element	Latin Name	Symbol
Iron	Ferrum	Fe
Gold	Aurum	Au
Copper	Cuprum	Cu
Potassium	Kalium	K
Sodium	Natrium	Na
Silver	Argentum	Ag
Mercury	Hydragyrum	Hg
Lead	Plumbum	Pb

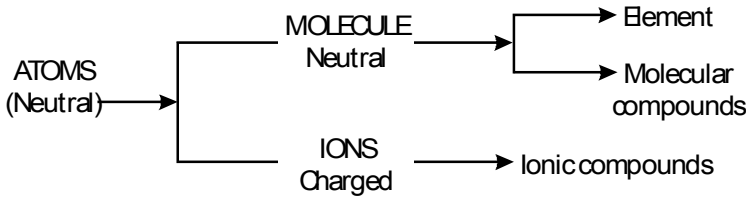
Atomic Mass : Atomic mass of an element may be defined as the average relative mass of an atom of the element as compared with mass of an atom of carbon (C-12 isotope) taken as 12 amu.

$$\text{Atomic mass : } \frac{\text{Mass of 1 atom of the element}}{\text{1/12 of the mass of an atoms of C-12}}$$

How do Atoms occur :

The atoms of only a few element called noble gases (such as helium, neon, argon and krypton etc.) which are chemically unreactive and exist in the free state (as single atom). Atoms of the elements are chemically very reactive and do not exist in the free state (as single atom)

Atoms usually exist in two ways :



Q. Define the atomic mass unit. **[NCERT]**

Q. Why is it not possible to see an atom with naked eyes? **[NCERT]**

MOLECULES

A molecule is the smallest particle of an element or compound that has independent existence. A molecule contain one or more than one atoms.

The molecules of elements contain atoms of only one kind.

The number of atoms in a molecule of an element is known as atomicity of the element. For example - The atomicity of the noble gases is 1, that of hydrogen, nitrogen, oxygen etc. is 2 each and of ozone is 3. Thus, noble gases, hydrogen and ozone are respectively monoatomic, diatomic and triatomic molecules.

Molecules of elements :

The molecules of an element contain two similar atom chemically bonded together, for example ozone gas has 3 oxygen atoms combined together , so ozone exists in the form of O_3. A recently discovered form of carbon, called Buckminster fullerene has molecular formula C_{60}.

Molecules of compounds :

The molecules of a compound contain two or more different types of atoms chemically bonded together. For example : the molecule sulphur dioxide (SO_2) contain one atom of sulphur chemically bonded with two atom of oxygen.

Molecular mass and formula mass :

The molecular mass of a substance (an element or a compound) may be defined as the average relative mass of a molecule of the substance as compared with mass of an atom of carbon (C-12 isotope) taken as 12 amu.

$$\text{Molecular Mass} = \frac{\text{Mass of 1 molecule of the substance}}{1/12 \text{ of mass of an atoms of C-12}}$$

The molecular mass of a compound can be obtained by adding atomic masses of all the atoms present in the molecule of the compound. For example, molecular mass of CO_2 is -

$$12 \times 1 + 16 \times 2 = 44 \text{ u}$$

Gram Molecular Mass :

Gram molecular mass of a substance is defined as that much quantity of the substance whose mass expressed in grams is numerically equal to its molecular mass.

For example : The molecular mass of CO_2 is 44 u, its gram molecular mass is 44g. Gram molecule mass of a substance is also known as gram-molecular mass of the substance.

Formula Mass :

Formula mass of an ionic compound is obtained by adding atomic masses of all the atoms in a formula unit of the compound.

For example : Formula mass of potassium chloride (KCl)

= Atomic mass of potassium + atomic mass of chlorine

39 + 35.5 = 74.5

Q. Calculate the molecular masses of H_2, O_2, Cl_2, CO_2, CH_4, C_2H_6, C_2H_4, NH_3, CH_3OH. **[NCERT]**

Q. Calculate the formula unit masses of ZnO, Na_2O, K_2CO_3, given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u and O = 16 u **[NCERT]**

Q. Calculate the molar mass of the following substances. **[NCERT]**

(a) Ethyne, C_2H_2

(b) Sulphur molecule, S_8

(c) Phosphorous molecule, P_4(Atomic mass of phosphorus = 31)

(d) Hydrochloric acid, HCl

(e) Nitric acid, HNO_3

Chemical formula :

The chemical formula of a compound describes the composition of a molecule of the compound in terms of the symbols of elements and the number of atoms of each element present in one molecule of the compound.

- In the chemical formula of a compound, the elements present are denoted by their symbols and the number of atoms of each element are denoted by writing their number as subscripts to the symbols of the respective element.

Example : Water is a compound whose one molecule is made up of two atoms of hydrogen and one atom of oxygen and hence its chemical formula is H_2O.

- While writing the formula of an ionic compound the metal is written on the left hand side while the non-metal is written on the right hand side. The name of the metal remains as such but that of the non-metal is changed to have the ending 'ide'.

  Example : MgO is named as magnesium oxide, KCl is named potassium chloride etc.

- Molecular compounds, formed by the combination between two different non-metals, are written in such a way that the less electronegative element is written on the left hand side while the more electronegative element is written on the right hand side. In naming molecular compounds, the name of the less negative non-metal is written as such but the name of the more electronegative element is changed to have the ending 'ide'.

  Example : H_2S is named as hydrogen sulphide.

- When there are more than one atoms of an element are present in the formula of the compound, then the number of atoms are indicated by the use of appropriate prefixes (Mono for : 1, di for 2, tri for 3. tetra for 4 atoms etc.) in the name of the compound.

  Example : CO_2 is named as carbon di oxide, CCl_4 is named as carbon tetra chloride.

  The prefixes are needed in naming those binary compounds in which the two non-metals form more than one compounds (by having different number of atoms).

  Example : Two non-metal, nitrogen and oxygen, combine to form different compound like nitrogen monoxide (NO), nitrogen di-oxide (NO_2), Nitrogen tri oxide (N_2O_3) etc.

- But, if two non-metals form only one compound, then prefixes are not used in naming such compounds.

  Example : Hydrogen and sulphur combine to form only one compound H_2S, So, H_2S is named as hydrogen sulphide and not hydrogen monosulphide.

  IONS : An ion is a positively or negatively charged atom (or group of atoms)

  These are two type of ions :

  (1) cations (2) anions

(1) **Cations :** A positively charged ion is known as cation. For example : Sodium ion:Na^+, Magnesium ion: Mg^{2+}

A cation is formed by the loss of one or more electrons by an atom

For example : sodium atom, loses one electron to form a sodium ion Na^+

Na $\xrightarrow{1e}$ Na^+ sodium ion

Sodium atom (A cation)

(2) **Anions :** A negatively charged ion is known as anion. Cl^- (chloride ion), O^{-2} (oxide ion) etc.

An anions is formed by the gain of one or more electrons by an atom. For example a chlorine atom gains one electron to form a chloride ion Cl^-.

- Cl $\xrightarrow{e}$ Cl^-

  Chlorine atom Chloride ion (An anion)

  Valency of ions : The valency of an ion is same as the Charge present on the ion.

* Monovalent cation (Valency of cation +1)

Example : Sodium ion (Na^+). Potassium ion (K^+), Hydrogen ion (H^+).

* Divalent cations (valency of cations + 2)

Example : Magnesium ion (Mg^{+2}) Ferrous ion (Fe^{+2})

* Trivalent cations (valency of cations + 3)

Example : Aluminium ion (Al^{+3}), Ferric ion (Fe^{+3}).

* Monovalent anion (anion of valency –1)

Example : Chloride ion (Cl^-), Bromide ion (Br^-)

* Divalent anions (Anions of Valency –2)

Example : Oxide ion (O^{-2}), Peroxide ion (O_2^{-2}) etc.

Trivalent anion (anions of valency –3)

Example : Nitride ion (N^{-3}), Phosphate ion (PO_4^{-3}) etc.

Writing of formula of Molecular compound :

Steps : . The steps to be followed for writing the formula of molecular compound are-

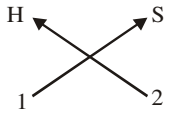
- First, write the symbols of the elements contributing in the compound.
- Then, below each symbol, write its corresponding valency
- Finally, we exchange the valencies of the combining atoms that is with first atom, we write the valency of the second atom and with second atom, we write the valency of the first atom, the valencies to be written as subscripts to the symbols.
- If the valencies have any common factor, then the formula is divided by the common factor. This gives the required formula of the compound.

Example : To work out the formula of hydrogen sulphide

(1) Hydrogen sulphide compound is made up of hydrogen and sulphur elements. So first we write down the symbol of hydrogen and sulphur.

(2) The valency of hydrogen is 1 and the valency of sulphur is 2. So below the symbol H we write 1 and below the symbol S we write 2.

Symbol	H	S
Valencies	1	2



Cross-Over valencies

- We now cross-over the valencies of H and S atoms. With H atom we write the valency of S (which is 2) so that it becomes H_2 with S atom we write the valency of H (which is 1) so that it becomes S_1. Now, joining together H_2 and S_1 the formula of hydrogen sulphide becomes H_2S_1 or H_2S (This is because we don't write the subscript 1 with an atom in a formula).

Q. What is meant by the term chemical formula? **[NCERT]**

Q. How many atoms are present in a **[NCERT]**

(i) H_2S molecule and (ii) PO_4^{3-} ion?

Q. What are polyatomic ions? Give examples **[NCERT]**

Q. Give the names of the elements present in the following compounds. **[NCERT]**

(a) Quick lime (b) Hydrogen bromide (c) Baking powder (d) Potassium sulphate

Writing the formula of Ionic compound :

Steps :

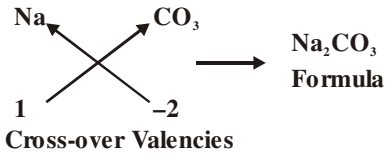
- First, write the symbols of the ions from which the ionic compound is made. As a convention, the cation is written on the left side while the anion is written on the right side.
- Then, the valencies of the respective cation and anion are written below their symbols.
- The valencies of the cation and anion are exchanged. The number of cation and anions in the formula of the compound are adjusted in such a way that total positive charge of cation become equal to the total negative charge of the anions making the ionic compound electrically neutral.
- The final formula of the ionic compound is then written but the charges present on the cation and the anion are not shown.

Example : To write the formula for sodium carbonate.

(1) First, write the symbol of sodium ion and carbonate ion and write their valencies below their symbols are shown.

Symbols	Na	CO_3
Valencies (or charges)	+1	–2

(2) Now, we exchange the valencies of sodium ion and carbonate ion,



(3) So –2 gets associated with Na and +1 gets associated with CO_3 in this way we get Na_2 and CO_3 and final formula of sodium carbonate is Na_2CO_3.

Q. Write down the formulae of **[NCERT]**

(i) sodium oxide (ii) aluminium chloride (iii) sodium sulphide (iv) magnesium hydroxide

Q. Write down the names of compounds represented by the following formulae : **[NCERT]**

(i) $Al_2(SO_4)_3$ (ii) $CaCl_2$ (iii) K_2SO_4

(iv) KNO_3 (v) $CaCO_3$

Q. Write the chemical formulae of the following. **[NCERT]**

(a) Magnesium chloride (b) Calcium oxide (c) Copper nitrate

(d) Aluminium chloride (e) Calcium carbonate

Name of the compound	Positive ion (cation)			Negative ion (anion)			Chemical Formula
	Name	Formula	Valency number	Name	Formula	Valency number	
Hydrogen chloride	Hydrogen	H	1	Chloride	Cl	1	HCl
Hydrogen sulphide	Hydrogen	H	1	Sulphide	S	2	H_2S
Sulphuric acid (hydrogen sulphate)	Hydrogen	H	1	Sulphate	SO_4	2	$H_2(SO_4)_1$, $H_2(SO_4)$
Sodium nitrate	Sodium	Na	1	Nitrate	NO_3	1	$Na_1(NO_3)_1$, $NaNO_3$
Aluminium Phosphate	Aluminium	Al	3	Phosphate	PO_4	3	$Al_3(PO_4)_3$, $AlPO_4$
Aluminium sulphate	Aluminium	Al	3	Sulphate	SO_4	2	$Al_2(SO_4)_3$
Ferrous sulphate	Ferrous	Fe	2	Sulphate	SO_4	2	$Fe_2(SO_4)_2$, $FeSO_4$
Ferric sulphate	Ferric	Fe	3	Sulphate	SO_4	2	$Fe_2(SO_4)_3$
Potassium dichromate	Potassium	K	1	Dichromate	Cr_2O_7	2	$K_2(Cr_2O_7)_1$, $K_2Cr_2O_7$
Magnesium nitrate	Magnesium	Mg	2	Nitrate	NO_3	1	$Mg(NO_3)_2$
Silver chromate	Silver	Ag	1	Chromate	Cr_2O_4	2	Ag_2CrO_4
Barium carbonate	Barium	Ba	2	Carbonate	CO_3	2	$Ba_2(CO_3)_2$, $BaCO_3$
Potassium permanganate	Potassium	K	1	Permanganate	MnO_4	1	$KMnO_4$
Calcium hydroxide	Calcium	Ca	2	Hydroxide	OH	1	$Ca(OH)_2$
Aluminium oxide	Aluminium	Al	3	Oxide	O	2	Al_2O_3
Magnesium phosphate	Magnesium	Mg	2	Phosphate	PO_4	3	$Mg_3(PO_4)_2$
Ammonium sulphate	Ammonium	NH_4	1	Sulphite	SO_3	2	$(NH_4)_2SO_3$
Zinc phosphate	Zinc	Zn	2	Phosphate	PO_4	3	$Zn_3(PO_4)_2$

– 1 Charge	**– 2 Charge**	**– 3 Charge**
Fluoride F^-	Sulphide S^{2-}	Phosphide P^{3-}
Chloride Cl^-	Oxide O^{2-}	Nitride N^{3-}
Bromide Br^-		
Iodide I^-		
Hydride H^-		

MOLE CONCEPT

Mole : Mole is a link between the mass of atoms (or molecules) and the number of atoms (or molecules). A group of 6.022×10^{23} particles (atom, molecules or ions) of a substance is called a mole of that substance.

Thus , 1 mole of atoms = 6.023×10^{23} atoms.

1 mole of molecules = 6.022×10^{23} molecules.

For example : oxygen atom is O and oxygen molecule is O_2.

1 mole of oxygen atoms (O) = 6.022×10^{23} oxygen atom

1 mole of oxygen molecules = 6.022×10^{23} oxygen molecules.

Number of 6.022×10^{23}, which represents a mole is known as ***Avogadro number.***

Moles of Atoms : One mole of atoms of an element has a mass equal to the gram atomic mass of the element.

1 mole of atoms of an element = Gram atomic mass of the element.

For example : The atomic mass of oxygen (O) is 16 u, so gram atomic mass of oxygen will be 16 gram.

1 mole of oxygen atoms = Gram atomic mass of oxygen = 16 gram.

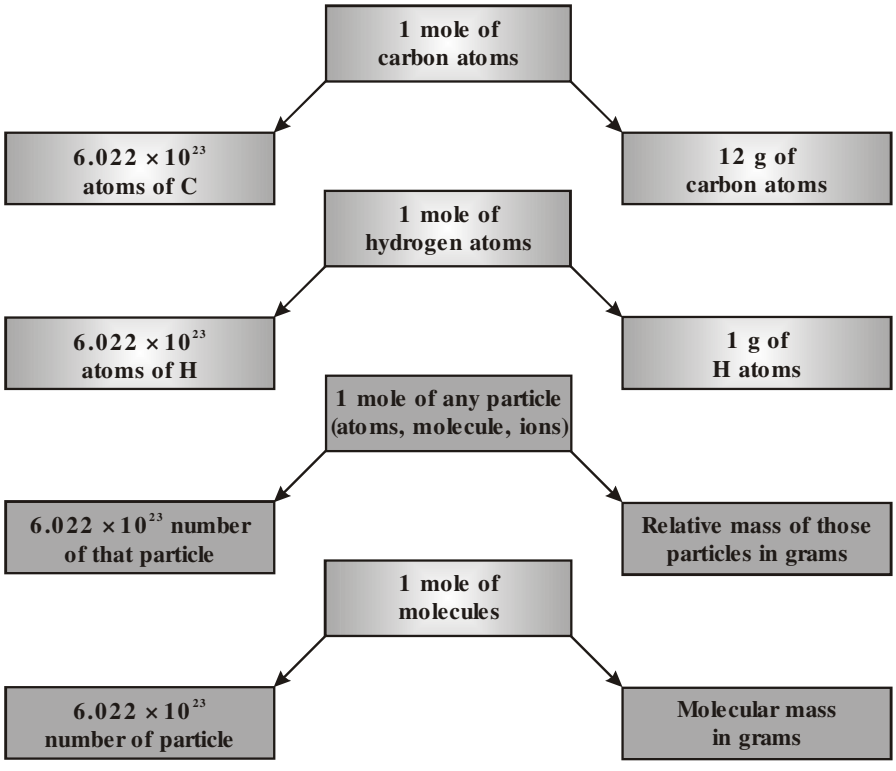
Mole of Molecules :

1 mole of molecules of an substance has mass equal to the gram molecular mass of the substance.

1 mole of molecules of a substance = Gram molecular mass of the substance.

For example : The molecular mass of oxygen (O_2) is 32 u. So the gram molecular mass of oxygen molecule is 32 grams.

1 mole of oxygen molecules = Gram molecular mass of oxygen = 32 gram.


1 mole of carbon atoms
6.022 × 10^23 atoms of C
12 g of carbon atoms
1 mole of hydrogen atoms
6.022 × 10^23 atoms of H
1 g of H atoms
1 mole of any particle (atoms, molecule, ions)
6.022 × 10^23 number of that particle
Relative mass of those particles in grams
1 mole of molecules
6.022 × 10^23 number of particle
Molecular mass in grams

Relationship between mole, Avogardro number and mass

Atomic masses of some common elements (in amu or u)							
S.No.	**Element**	**Symbol**	**Atomic mass**	**S.No.**	**Element**	**Symbol**	**Atomic mass**
1	Hydorgen	H	1	**14**	Sulphur	S	32
2	Helium	He	4	**15**	Chlorine	Cl	35.5
3	Lithium	Li	7	**16**	Argon	Ar	40
4	Boron	B	11	**17**	Potassium	K	39
5	Carbon	C	12	**18**	Calcium	Ca	40
6	Nitrogen	N	14	**19**	Iron	Fe	56
7	Oxygen	O	16	**20**	Copper	Cu	63.5
8	Fluorine	F	19	**21**	Zinc	Zn	65
9	Neon	Ne	20	**22**	Silver	Ag	108
10	Sodium	Na	23	**23**	Platinum	Pt	195
11	Magnesium	Mg	24	**24**	Gold	Au	197
12	Aluminium	Al	27	**25**	Lead	Pb	207
13	Phosphorus	P	31	**26**	Uranium	U	238

Mass percentage of an element from molecular formula :

The molecular formula of a compound may be defined as the formula which specifies the number of atoms of various element in the molecule of the compound.

For example : The molecular formula of glucose is $C_6H_{12}O_6$. This shows that a molecule of glucose contains six atoms of carbon, twelve atoms of hydrogen and six atoms of oxygen. With the help of molecular formula of a compound we can calculate its percentage composition by mass. First we calculate the molecular mass of the compound. From this we can find out mass of one mole of the compound, which is equal to its gram molecular mass. Then we calculate mass of each element in one mole of the compound. The mass percentage of each element is then calculated by the following formula.

$$\text{Mass percentage of element X} = \frac{\text{Mass of X in one mole}}{\text{Mass of one mole of the compound that is gram molecular mass}} \times 100$$

Determination of Molecular formula :

To find out the molecular formula of a compound, the first is to determine its empirical formula from the percentage composition. The empirical formula of a compound may be defined as the formula which gives the simplest whole number ratio of atoms of the various elements present in the molecule of the compound.

For example : The empirical formula of the compound glucose ($C_6H_{12}O_6$) is CH_2O which shows that C, H and O are present in the simplest ratio of 1 : 2 : 1.

Molecular formula is whole number multiple of empirical formula thus,

Molecular formula = Empirical formula × n

$$n = \frac{\text{Molecular formula}}{\text{Empirical formula}}$$

Where n = 1, 2, 3.....

$$n = \frac{\text{Molecular Mass}}{\text{Empirical formula mass}}$$

Steps for writing an empirical formula :

The percentage of the element in the compound is determined by suitable methods and from the data collected, the empirical formula is determined by the following steps-

- Divide the percentage of each element by its atomic mass. This gives the relative number of moles of various elements present in the compound.
- Divide the quotients obtained in the above step by the smallest of them so as to get a simple ratio of moles of various elements.
- Multiply the figures, so obtained by a suitable integer, if necessary, in order to obtain whole number ratio.
- Finally write down the symbols of the various elements side by side and put the above number as the subscripts to the lower right hand corner of each symbol. This will represent the empirical formula of the compound.

Steps for writing the molecular formula :

- Calculate the empirical formula as describe above.
- Find out the empirical formula mass by adding the atomic masses of all the atoms present in the empirical formula of the compound.
- Divide the molecular mass (determined experimentally by some suitable method) by the empirical formula mass and find out the value of "n"
- Multiply the empirical formula of the compound with n so as to find out the molecular formula of the compound.

ROUND UP

While doing numerical problems of mole concept, the following relations should be remembered.

Key for symbols

Number of moles = n

Given mass = m

Molar mass = M

Given number of particle = N

Avogadro number of particle = N_0

Key Formula

1 mole of atoms = 6.022×10^{23} atoms = Gram atomic mass or Molar mass of element

$$\text{Number of moles} = \frac{\text{Mass of element}}{\text{Molar mass}}$$

$$n = \frac{m}{M}$$

$$\text{Number of moles} = \frac{\text{Given number of atoms}}{\text{Avogadro number}}$$

$$n = \frac{N}{N_0}$$

These relations can be interchanged as

Mass of element, $m = n \times M$

or Number of particles of element, $N = n \times N_0$

Similarly,

1 mole of molecules = 6.022×10^{23} molecules = Gram molecular mass or Molar mass

$$\text{Number of moles} = \frac{\text{Mass of substance}}{\text{Molar mass}}$$

$$n = \frac{m}{M}$$

$$\text{Number of moles} = \frac{\text{Given number of molecules}}{\text{Avogadro number}}$$

$$n = \frac{N}{N_0}$$

or $m = n \times M$ and $N = n \times N_0$

Let us apply these formula to solve numerical problems.

IMPORTANT POINTS

- An element is a ure substance which cannot be split into two or more simpler substance s by any physical or chemical means. It is the simplest form of matter.
- Elements may be metals, nonmetals or metalloids.

NCERT QUESTIONS WITH SOLUTIONS

Q.1 In a reaction, 5.3 g of sodium carbonate reacted with 6 g of ethanoic acid. The products were 2.2 g of carbon dioxide, 0.9 g water and 8.2 g of sodium ethanoate. Show that these observations are in agreement with the law of conservation of mass.

Sodium carbonate + Ethanoic acid $\longrightarrow$ Sodium Ethanoate + Carbon dioxide + Water

Ans. Sodium carbonate + Ethanoic acid $\longrightarrow$ Sodium Ethanoate + Carbon dioxide + Water

(5.3g) (6g) (8.2g) (2.2g) (0.9g)

Mass of reactants = Mass of sodium carbonate + Mass of ethanoic acid
= 5.3 + 6 = 11.3g

Mass of products = Mass of sodium ethanoate + Mass of carbon dioxide + Mass of water
= 8.2 + 2.2 + 0.9 = 11.3g

Here, mass of reactants = mass of products. It means there is no net change in the mass, i.e., before the reaction and after the reactions, i.e., the mass is constant. So, these observations are in agreement with the law of conservation of mass.

Q.2 Hydrogen and oxygen combine in the ratio of 1:8 by mass to form water. What mass of oxygen gas would be required to react completely with 3g of hydrogen gas?

Ans. 1 g hydrogen requires 8 g of oxygen.
$\therefore$ 3g of hydrogen requires = 3 × 8 = 24 g of oxygen.

Q.3 Which postulate of Dalton's atomic theory is the result of the law of conservation of mass?

Ans. Atoms are indivisible which can neither be created nor destroyed in a chemical reaction. this is the postulate which is based on the law of conservation of mass.

Q.4 Which postulate of Dalton's atomic theory can explain the law of definite proportions?

Ans. "The relative number and kind of atoms are constant in a given compound." this is the postulate which explains the law of definite proportion.

Q.6 Define the atomic mass unit.

Ans. The atomic mass unit (amu) is equal to $1/12^{th}$ part of the mass of one atom of C-12.
1 amu = $1/12^{th}$ part of C-12 isotope of carbon.

Q.7 Why is it not possible to see an atom with naked eyes?

Ans. Because the size of atom is very small which is beyond the capacity of our eyes, as the atoms are in the range of $10^{-9} - 10^{-10}$ m.

Q.8 Write down the formulae of

(i) sodium oxide (ii) aluminium chloride
(iii) sodium sulphide (iv) magnesium hydroxide

Ans. (i) sodium oxide = Na_2O (ii) Aluminium chloride = $AlCl_3$
(iii) Sodium sulphide = Na_2S (iv) Magnesium hydroxide = $Mg(OH)_2$

Q.9 Write down the names of compounds represented by the following formulae:

(i) $Al_2(SO_4)_3$ (ii) $CaCl_2$ (iii) K_2SO_4 (iv) KNO_3 (v) $CaCO_3$

Ans. (i) $Al_2(SO_4)_2$ = Aluminium sulphate (ii) $CaCl_2$ = Calcium chloride
(iii) K_2SO_4 = Potassium sulphate (iv) KNO_3 = Potassium nitrate
(v) $CaCO_3$ = Calcium carbonate

Q.10 What is meant by the term chemical formula?

Ans. The short hand notation or representation of a compound or element is called its chemical formula. It represents the composition of a molecule of the substance in terms of the symbols of the elements present in the molecule. For example, ammonia is a compound and its chemical formula is NH_3.

Q.11 How many atoms are present in a:
(i) H_2S molecule (ii) PO_4^{3-} ion?

Ans. (i) H_2S molecule = 3 atoms (ii) PO_4^{3-} ion = 5 atoms

Q.12 Calculate the molecular masses of H_2, O_2, Cl_2, CH_4, C_2H_6, C_2H_4, NH_3, CH_3OH.

Ans.

H_2	$= 2 \times H$ $= 2 \times 1$ $= 2$ u	O_2	$= 2 \times O$ $= 2 \times 16$ $= 32$ u	Cl_2	$= 2 \times Cl$ $= 2 \times 35.5$ $= 71$ u
CO_2	$= 1 \times C + 2 \times O$ $= 1 \times 12 + 2 \times 16$ $= 44$ u	CH_4	$= 1 \times C + 4 \times H$ $= 12 + 4$ $= 16$ u	C_2H_6	$= 2 \times C + 6 \times H$ $= 2 \times 12 + 6 \times 1$ $= 30$ u
C_2H_4	$= 2 \times C + 4 \times H$ $= 24 + 4$ $= 28$ u	NH_3	$= 1 \times N + 3 \times H$ $= 1 \times 14 + 3 \times 1$ $= 17$ u	CH_3OH	$= 1 \times C + 4 \times H + 1 \times O$ $= 1 \times 12 + 4 \times 1 + 1 \times 16$ $= 12 + 4 + 16$ $= 32$ u

Q.13 Calculate the formula unit masses of ZnO, Na_2O, K_2CO_3, given atomic masses of Zn = 65u, Na = 23u, K = 39u, C = 12u, O = 16u.

Ans. Formula unit mass of

ZnO	$= 1 \times Zn + 1 \times O$ $= 1 \times 65 + 1 \times 16$ $= 81$ u	Na_2O	$= 2 \times Na + 1 \times O$ $= 2 \times 23 + 1 \times 16$ $= 46 + 16$ $= 62$ u	K_2CO_3	$= 2 \times K + 1 \times C + 3 \times O$ $= 2 \times 39 + 1 \times 12 + 3 \times 16$ $= 78 + 12 + 48$ $= 138$ u

Q.14 If one mole of carbon atoms weighs 12g. What is the mass (in grams) of 1 atom of carbon?

Ans. We know that one mole = 6.022×10^{23} atoms

The mass of 6.022×10^{23} atoms = 12g

$\therefore$ The mass of one atom = $\frac{12}{6.022 \times 10^{23}}$ g = 1.99×10^{-23} g

Q.15 Which has more number of atoms: 100g of sodium or 100g of iron (given atomic mass of Na = 23u, Fe = 56u)?

Ans. To know the number of atoms, we must know the number of moles, (n) = $\frac{m}{M}$

Number of moles of Na = $\frac{100}{23}$ mole

Number of atoms of Na = n × N_0 ($N_0 = 6.022 \times 10^{23}$).

$= \frac{100}{23} \times 6.022 \times 10^{23} = 2.62 \times 10^{24}$ atoms

Number of atoms of Fe = $\frac{100}{56} \times 6.022 \times 10^{23}$

$= 1.075 \times 10^{24}$ atoms

Therefore, 100 grams of Na will have more number of atoms.

Q.16 A 0.24g sample of compound of oxygen and boron was found by analysis to contain 0.096 g of boron and 0.144 g of oxygen. Calculate the percentage composition of the compound by weight.

Ans. % of the element $= \frac{\text{Mass of the element in the compound}}{\text{Mass of the compound}} \times 100$

% of boron $= \frac{\text{Mass of boron}}{\text{Mass of compound}} \times 100 = \frac{0.096}{0.24} \times 100 = \frac{96}{24} \times 10 = 40\%$

% of oxygen $= \frac{\text{Mass of oxygen}}{\text{Mass of compound}} \times 100 = \frac{0.144}{0.24} \times 100 = \frac{144}{24} \times 10 = 60\%$

Q.17 When 3.0g of carbon is burnt in 8.00 g of oxygen, 11.00 g of carbon dioxide is produced. What mass of carbon dioxide will be formed when 3.00 g of carbon is burnt in 50.00 g of oxygen. Which law of chemical combination will govern your answer?

Ans. $C + O_2 \longrightarrow CO_2$

3g 8g 11g

Mass of reactants = Mass of carbon + Mass of oxygen = 3 + 8 = 11g, Mass of products (CO_2) = 11g

$\therefore$ Mass of reactants = Mass of products

So, here the law of conservation of mass is followed. If 3 grams of carbon burns in 50g of oxygen even then it will produce 11g of CO_2 because 3 grams of carbon will combine with fixed amount of oxygen, i.e., 8g. So, the law of constant composition is also followed.

Q.18 What are polyatomic ions? Give examples.

Ans. Those ions which have more than two atoms (group of atoms) are called polyatomic ions.

Example: CO_3^{2-} (carbonate ion), SO_4^{2-} (sulphate ion)

PO_4^{3-} (phosphate ion), NH_4^+ (ammonium ion)

Q.19 Write chemical formulae of the following:

(a) Magnesium chloride (b) Calcium oxide (c) Copper (II) nitrate

(d) Aluminium chloride (e) Calcium carbonate

Ans. (a) Magnesium chloride

Symbol Mg Cl

Valency 2 1

Chemical formula = $MgCl_2$

(b) Calcium oxide

Symbol Ca O

Valency 2 2

Chemical formula = CaO

(c) Copper (II) nitrate

Symbol Cu NO_3

Valency 2 1

Chemical formula = $Cu(NO_3)_2$

(d) Aluminium chloride

Symbol Al Cl

Valency 3 1

Chemical formula = $AlCl_3$

(e) Calcium carbonate

Symbol Ca CO_3

Valency 2 2

Chemical formula = $CaCO_3$

Q.20 Give the names of the elements present in the following compounds:
(a) Quick lime (b) Hydrogen bromide (c) Baking powder (d) Potassium sulphate

Ans.

Compounds	Chemical formula	Constituent elements
a) Quick lime	CaO	Calcium and oxygen
b) Hydrogen bromide	HBr	Hydrogen and bromine
c) Baking powder	$NaHCO_3$	Sodium, hydrogen, carbon and oxygen
d) Potassium sulphate	K_2SO_4	Potassium, sulphur and oxygen

Q.21 Calculate the molar mass of the following substances:
(a) Ethyne, C_2H_2
(b) Sulphur molecule, S_8
(c) Phosphorus molecule, P_4 (atomic mass of phosphorus = 31)
(d) Hydrochloric acid, HCl
(e) Nitric acid, HNO_3

Ans. (a) Molecular mass of ethyne, C_2H_2 = 2 × atomic mass of C + 2 × atomic mass of H
= 2 × 12 + 2 × 1 = 24 + 2
= 26 u
Molar mass = 26g/mol

(b) Molecular mass of sulphur molecule, S_8 = 8 × atomic mass of S = 8 × 32
= 256 u
Molar mass = 256 g/mol

(c) Phosphorus molecule, P_4 = 4 × atomic mass of P
= 4 × 31
= 124 u
Molar mass = 124 g/mol

(d) Molecular mass of hydrochloric acid, HCl = 1 × atomic mass of Cl
= 1 × 1 + 1 × 35.5 = 36.5u
Molar mass = 36.5 g/mol

(e) Molecular mass of nitric acid, HNO_3 = 1 × atomic mass of H + 1 × atomic mass of N + 3 × atomic mass of O
= 1 × 1 + 1 × 14 + 3 × 16
= 1 + 14 + 48
= 63 u
Molar mass = 63 g/mol

Q.22 What is the mass of:
(a) 1 mole of nitrogen atoms?
(b) 4 moles of aluminium atoms (Atomic mass of aluminium = 27)?
(c) 10 moles of sodium sulphite (Na_2SO_3)?

Ans. (a) Mass of 1 mole nitrogen atoms, m = n × M
= 1 × 14 = 14g

(b) Mass of 4 mole aluminium atoms, m = n × M
= 4 × 27 = 108 g

(c) Mass of 10 moles of Na_2SO_3, m = n × M
M = 2 × atomic mass of Na + 1 × atomic mass of S + 3 × atomic mass of O
= 2 × 23 + 1 × 32 + 3 × 16
= 46 + 32 + 48
= 126
m = 10 × 126
= 1260 g

Q.23 Convert into mole.
(a) 12g of oxygen gas (b) 20g of water (c) 22g of carbon dioxide

Ans. (a) Molar mass of oxygen (M) = 2 × 16 = 32g/mol
Mass of oxygen, m = 12g

Number of moles in 12g of oxygen gas, $n = \frac{m}{M} = \frac{12}{32} = \frac{3}{8}$ mole = 0.375 mole

(b) Molar mass of water, $M_{H_2O} = 1 \times 2 + 1 \times 16 = 18$ g/mol

Mass of H_2O,(m) = 20g

(c) Molar mass of CO_2(M) = 12 + 2 × 16 = 44 g/mol
Mass of CO_2(m) = 22g

Number of moles in 22g CO_2(n) = $\frac{m}{M} = \frac{22}{44} =$ 0.5 mole

Q.24 What is the mass of:
(a) 0.2 mole of oxygen atoms? (b) 0.5 mole of water molecules?

Ans. (a) Molar mass of oxygen atoms(M) = 16 g/mol
Mass of 0.2 mole of oxygen atoms, m = n × M = 0.2 × 16 = 3.2 g
(b) 0.5 mole of water molecules = n
Molar mass of water molecule(M) = 2 + 16 = 18 g/mol
∴ Mass of 0.5 mole of water(M) = n × M = 0.5 × 18 = 9 gram

Q.25 Calculate the number of molecules of sulphur (S_8) present in 16g of solid sulphur.

Ans. Given, 16 grams of sulphur = m
Molecular mass of sulphur (M) = 8 × atomic mass of S
= 8 × 32 = 256 u
∴ Molar mass(M) = 256 g/mol

Number of moles of sulphur(n) = $\frac{m}{M} = \frac{16}{256} = \frac{1}{16}$ mole

Number of sulphur molecules = n × Avogadro's number (N_0)

$= \frac{1}{16} \times 6.022 \times 10^{23}$
$= 3.76 \times 10^{22}$ molecules.

Q.26 Calculate the number of a aluminium ions present in 0.051 g of aluminium oxide.
(Hint: The mass of an ion is the same as that of an atom of the same element. Atomic mass of Al = 27u)

Ans. Mass of aluminium oxide (Al_2O_3) = m = 0.051g

Molar mass of aluminium oxide, $M_{Al_2O_3}$ $= 2 \times 27 + 3 \times 16$
$= 54 + 48 = 102$ g/mol

Number of moles of aluminium oxide (n) $= \frac{0.051}{102} = \frac{51 \times 10^{-3}}{102}$
$= 0.5 \times 10^{-3}$ moles of Al_2O_3

Number of Al_2O_3 molecules $= 0.5 \times 10^{-3} \times 6.022 \times 10^{23}$
$= 3.011 \times 10^{20}$

$Al_2O_3 \rightarrow 2Al^{3+} + 3O^{2-}$

One molecule of Al_2O_3 gives $= 2Al^{3+}$ ions
∴ 3.011×10^{20} molecules will give $= 2 \times 3.011 \times 10^{20}$ Al^{3+} ions
$= 6.022 \times 10^{20}$ Al^{3+} ions

EXERCISE – I

OBJECTIVE TYPE QUESTIONS :

Q.1 The elements present in baking soda are -

(A) Sodium, carbon and oxygen

(B) Sodium, carbon and hydrogen

(C) Sodium, carbon, hydrogen and oxygen

(D) Potassium, carbon and oxygen

Q.2 The first scientist to use of the symbols of elements was-

(A) Dalton (B) Berzillius

(C) Kanad (D) Proust

Q.3 The overall charge on an ionic compound is equal to -

(A) Charge of the cation present

(B) Zero

(C) Charge of the anion present

(D) sum of charges of the cation & anion

Q.4 The chemical formula of the copper nitrate -

(A) $Cu(NO_3)_2$ (B) $CuNO_3$

(C) $Cu_2(NO_3)_3$ (D) Cu_2NO_3

Q.5 The number of carbon atoms in 1g of $CaCO_3$ is-

(A) 6.022×10^{23} (B) 6.022×10^{21}

(C) 3.0125×10^{22} (D) 1.204×10^{23}

Q.6 The mass of a single atom of carbon is -

(A) 12 g (B) 1/12 g

(C) 1.99×10^{-23}g (D) 1.99×10^{23}g

Q.7 The mass of 1 u is -

(A) $\frac{1}{12} \times \frac{1}{6.022 \times 10^{23}}$ g

(B) $\frac{1}{6.022 \times 10^{23}}$ g

(C) $\frac{12}{6.022 \times 10^{23}}$ g

(D) 6.022×10^{23} g

Q.8 How many molecules are present in 9g of water -

(A) 3.01×10^{23} (B) 6.022×10^{23}

(C) 6.08×10^{23} (D) 3.82×10^{23}

Q.9 $Mg + O_2 \xrightarrow{\text{Burning}}$ 'X' , 'X' is -

(A) MgO (B) Mg_2O

(C) MgO_2 (D) Mg_2O_3

Q.10 The formula of sulphuric acid is-

(A) H_2SO_3 (B) H_2SO_4

(C) H_2SO_5 (D) $H_2S_2O_7$

Q.11 What is true about potassium chlorate -

(A) It gives oxygen gas on strong heating

(B) Its molecular mass is 122.5kg/mol

(C) 122.5g of it contain oxygen atoms three times the Avogadro number

(D) Its molecular formula is $KClO_4$

Q.12 Mass of one Avogadro's number of O atom is equal to -

(A) 16 amu (B) 16g

(C) 32g (D) 6kg

Q.13 Hydrogen reacts with oxygen to form water (H_2O). The ratio between masses of Hydrogen and oxygen is -

(A) 1 : 8 (B) 63.5 : 8

(C) 2 : 1 (D) 63.5 : 16

Q.14 The correct formula of aluminium sulphate is

(A) $AlSO_4$ (B) Al_2SO_4

(C) $Al_3(SO_4)_2$ (D) $Al_2(SO_4)_3$

Q.15 Which of the following has highest intermolecular forces of attraction -

(A) Liquid water (B) Liquid ethyl alcohol

(C) Gaseous CO_2 (D) Solid CO_2

Q.16 Which of the following is not correct regarding gases-

(A) Gases exert pressure

(B) Gases have same intermolecular space

(C) Gases have tendency to diffuse

(D) Gases have high intermolecular forces of attraction

Q.17 The Boiling point of water at normal atmospheric pressure is -

(A) 273 K (B) 373 K

(C) 100 K (D) 0°C

Q.18 Avogadro's number represents the number, of atoms in-

(A) 12g of C^{12} (B) 320g of sulphur
(C) 32g of oxygen (D) 12.7 g of iodine

Q.19 Molecular mass of ozone is

(A) 16 u (B) 32 u
(C) 48 u (D) 64 u

Q.20 Which of the following is not correct according to Dalton's atomic theory?

(A) Matter is made up of atoms

(B) Atoms of all substances are identical in all respects

(C) Atoms combine in a simple whole number ratio

(D) Atoms of two elements can combine to form more than one compound.

FILL IN THE BLANKS :

Q.21 The temperature at which a liquid changes into gas is called.....

Q.22 Intermolecular space in solid is ..... than that of liquids

Q.23 Change of liquid state to solid state is called .....

Q.24 Smell of cooked food reaches us in seconds due to the process known as. .....

Q.25 One mole atoms of oxygen contains .....atoms of oxygen.

Q.26 The number of atoms in a molecule of the elementary substance called is .....

Q.27 In water, the proportion of hydrogen and oxygen is .....by mass.

Q.28 Latin name of mercury is .....

Q.29 Avogadro number is .....

Q.30 One mole of sodium sulphate contains ..... atoms of sodium, ... atoms of sulphur and ..... atoms of oxygen.

Q.31 Intermolecular forces are maximum in .....

Q.32 Water has boiling point equal to .....

Q.33 Fusion is a change of .....to .....state.

MATCH THE COLUMN :

Q.34 Match the following elements & compounds given in column-A with column-B

Column-A Elements compound	**Column-B** Atomicity
(1) Argon	(a) 8
(2) Sulphur	(b) 4
(3) Oxygen	(c) 2
(4) Phosphorous	(d) 1
(5) Ozone	(e) 3
(6) Bromine	(f) 5
(7) Carbon monoxide	(g) 6
(8) Hydrogen peroxide	(h) 7
(9) Lime water	
(10) Ammonia	
(11) Quick Lime	
(12) Baking Powder	
(13) Lime Stone	
(14) Common salt	
(15) Sodium Sulphate	

ANSWER KEY

Objective type questions

1.	C	**2.**	A	**3.**	B	**4.**	A
5.	B	**6.**	C	**7.**	B	**8.**	A
9.	A	**10.**	B	**11.**	C	**12.**	B
13.	A	**14.**	D	**15.**	D	**16.**	D
17.	B	**18.**	A	**19.**	C	**20.**	B

Fill in the blanks

21.	boiling point	**22.**	less
23.	solidification	**24.**	diffusion
25.	Contain 6.022×10^{23}	**26.**	Atomicity
27.	1 : 8	**28.**	Hydragyrum

29. 6.022×10^{23}

30. 12.044×10^{23} , 6.022×10^{23}, 24.088×10^{23}

31. Solid **32.** 100°C

33. Solid, liquid

Match the column

1.	d	**2.**	a	**3.**	c	**4.**	b
5.	e	**6.**	c	**7.**	c	**8.**	b
9.	f	**10.**	b	**11.**	c	**12.**	g
13.	f	**14.**	c	**15.**	h		

EXERCISE – II

VERY SHORT ANSWER TYPE QUESTION :

Q.1 Name of the building block of all matter.

Q.2 What are the symbols of copper and cobalt ?

Q.3 What is 1 u ?

Q.4 Give symbols for the following elements : Aluminium, Tin, Bromine, Neon.

Q.5 What is ratio between masses of

(i) hydrogen and oxygen in H_2O

(ii) nitrogen and hydrogen in NH_3?

[Atomic mass of H = 1 u, O = 16 u, N = 14 u]

Q.6 What is meant by formula unit mass?

Q.7 What is meant by valency of an element?

Q.8 10 g silver nitrate solution are added to 10 g of sodium chloride solution. What change in mass do you expect after the reaction?

Q.9 Why is copper represented by the symbol 'Cu' while there is no letter 'u' in the name?

Q.10 What do you understand by the 'atomicity' of the substance?

Q.11 Give two examples each of bivalent cations and bivalent anions.

Q.12 How are mass, molar mass and number of moles related to each other?

SHORT ANSWER TYPE QUESTION :

Q.13 What is the first law of chemical combination ?

Q.14 What is the conclusion of the Dalton's atomic theory ?

Q.15 Define a molecule. How many molecules are present in

(i) 9g of water (ii) 17g of ammonia

Q.16 What is meant by the term chemical formula ?

Q.17 What are poly atomic ions ? Give example.

Q.18 Calculate the number of molecules of Sulphur (S_8) present in 16g of solid sulphur.

Q.19 Give the names of the elements present in the following compounds.

(i) Baking powder

(ii) Calcium carbonate

(iii) Hydrogen bromide

Q.20 Define the term mole.

Q.21 Write the molecular formula of the following and give the ratio by mass of atoms present ?

(i) Ammonia (ii) Water

(iii) Methane

Q.22 A hydrogen is found to contain 14.3% hydrogen and 85.7% carbon. If molecular mass of the hydrocarbon is 28, find out its molecular formula (17g).

Q.23 Write down the names of the compound represented by the following formula :-

(i) $Al_2(SO_4)_3$ (ii) $CaCl_2$

(iii) K_2SO_4 (iv) KNO_3

Q.24 What is meant by the term chemical formula?

Q.25 Calculate the mass of CO_2 which will contain the same number of molecules as are contained in 40.0 g of oxygen.

Q.26 If 1 g of SO_2 contains x molecules, what will be the number of molecule in 1 g of methane? (S = 32 u, O = 16 u, C = 12 u, H = 1 u)

Q.27 What is 'molar volume'? What is its value?

Q.28 Define the "law of constant proportions". How does Dalton's atomic theory explain the truth of the law?

Q.29 What is the difference between the actual mass of a molecule and gram molecular mass?

Q.30 What is formula unit mass? For what type of compounds is it used and why?

Q.31 What is the unit of atomic mass or molecular mass? Define it. What is the mass of this unit in kilograms?

LONG ANSWER TYPE QUESTION :

Q.32 State and explain Law of Conservation Mass. How does Dalton's atomic theory explain this law?

Q.33 State and explain the following :

(i) Atom (ii) Molecule

(iii) Atomic mass (iv) Molecular mass

Q.34 Arrange the following in order of increasing masses : (i) 0.1 g atom of silver (ii) 0.1 mole of H_2SO_4 (iii) 10^{23} molecule of CO_2 gas (iv) 1 gram of carbon (v) 10^{23} atoms of calcium.

(Atomic masses : Ag = 108 u, S = 32 u, N = 14 u, Ca = 40 u)

Q.35 How is the molecular formula of a compound related to its empirical formula?

Q.36 Valencies or the charge numbers of some ions are given below :

Aluminium ion	3^+
Magnesium ion	2^+
Potassium ion	1^+
Nitride ion	3^-
Sulphate ion	2^-
Fluoride ion	1^-

Using the above information, write down the chemical formulae of the following :

(i) Aluminium ion

(ii) Magnesium nitride

(iii) Aluminium sulphate

(vi) Potassium fluoride

(v) Magnesium fluroide

(vi) Potassium nitride

Q.37 The molecular formula of a compound is CH_3OH. Calculate its molecular mass in atomic mass units. Also write down its molar mass. (atomic masses are : H = 1 u, C = 12 u, O = 16 u)

Q.38 Find the number of atoms of each type present in 3.42 grams of canesugar ($C_{12}H_{22}O_{11}$).

Q.39 What are the postulates and limitations of Dalton's atomic theory?

ANSWER KEY

1. atoms

2. Cu & Co

3. 1 u stands for one twelth (1/12) in the mass of a carbon (carbon-12) atom,

4. Al, Sn, Br, Ne,

5. (i) 1 : 8 (ii) 14 : 3

6. Refer theory

7. Refer theory

8. No change

9. Symbol Cu has been taken from the latin word 'cuprum' which means copper

10. The number of atoms present in one molecule of the substance is called atomicity

11. Cations = Zn^{2+}, Mg^{2+}, anions = SO_4^{2-}, CO_3^{2-}

12. Number of moles (n) = $\frac{\text{Given mass (m)}}{\text{Molar mass (M)}}$ or m = n × M.

13. Law of conservation of mass

14. Refer theory

15. (i) 3.011×10^{23} (ii) 6.021×10^{23}

16. Refer theory

17. SO_4^{-2}, NO_3^-

18. 3.76×10^{23}

19. (i) Na, H, C, O (ii) Ca, C, O (iii) H, Br

20. 1 mole = N_A molecule

21. (i) 14 : 3 (ii) 1 : 8 (iii) 3 : 1

22. C_2H_4

23. (i) Aluminium sulphate

(ii) Calcium chloride

(iii) Potassium sulphate

(iv) Potassium nitrate

25. 110g

26. 4x molecule

34. (i) 10.8 g (ii) 9.8g (iii) 7.306g

(iv) 1g (v) 6.642g

order (i) > (ii) > (iii) > (v) > (iv)

35. n = $\frac{\text{molecular formulae}}{\text{empirical formulae}}$

36. (i) $A\ell^{+3}$ (ii) Mg_3N_2 (iii) $Al_2(SO_4)_3$
(iv) KF (v) MgF_2 (vi) K_3N

37. 32u

EXERCISE – III

Q.1 The law of multiple proportions was proposed by :-
(A) Lavoisier (B) Dalton
(C) Proust (D) Ritcher

Q.2 The weight of two elements which combine with each other are in the ratio of their :-
(A) Atomic heights
(B) Atomic volumes
(C) Equivalent weight
(D) Molecular weights

Q.3 180 grams of water conatins _____ moles :-
(A) 100 (B) 10
(C) 180 (D) 0.01

Q.4 What is the weight of 3 gram atoms of sulphur ?
(A) 96 gm (B) 99 gm
(C) 100 gm (D) 3 gm

Q.5 How many gram atoms are present in 144 g of magnesium ?
(A) 12 (B) 6
(C) 100 (D) 144

Q.6 How many moles of oxygen atoms are present in one mole of acetic acid ?
(A) 1 mole (B) 3 moles
(C) 2 moles (D) 6 moles

Q.7 What is the number of particles in one mole of a substance ?
(A) 6.023×10^{23} (B) 6.023×10^{-23}
(C) 6.023 (D) 3×10^{8}

Q.8 How many atoms and how many gram atoms are there in 10 grams of calcium ?
(A) 0.25 gram atoms, 6.023×10^{-23} atoms
(B) 0.25 gram atoms, 1.50×10^{23} atoms
(C) 0.1 gram atoms, 6.023×10^{23} atoms
(D) 0.1 gram atoms, 1.50×10^{-23} atoms

Q.9 Calculate the weight of 0.1 mole of sodium carbonate :-
(A) 1.06 g (B) 11.06 g
(C) 10.6 g (D) 1.106 g

Q.10 How many number of moles are present in 540 g of glucose?
(A) 2 moles (B) 3 moles
(C) 4 moles (D) 1 moles

Q.11 How much of lime can be obtained by burning 400 g of lime stone ?
(A) 224 g (B) 220 g
(C) 400 g (D) 320 g

Q.12 Chemical analysis of a carbon compound gave the following percentage composition by weight of the elements present in it. Carbon = 10.06%, hydrogen = 0.84%, chlorine = 89.10%. Calculate the empirical formula of the compound :-
(A) $C_2H_2Cl_2$ (B) $CHCl_2$
(C) $CHCl_3$ (D) $C_4H_4Cl_4$

Q.13 0.202 g of a carbon compound, on combustion, gave 0.361 g of carbon dioxide and 0.47 g of water. Calculate the percentage composition of carbon :-
(A) 48.76% (B) 8.07%
(C) 43.17% (D) 42.17%

Q.14 One mole of CO_2 contains :
(A) 1 gram atom of carbon
(B) 2 gram atoms of oxygen
(C) 3 gram atoms of carbon and oxygen
(D) all of the above

Q.15 The percentage of nitrogen in ammonia is given by the expression :-
(A) $\frac{14\times100}{17}$ (B) $\frac{3}{17}$ 100
(C) $\frac{14\ \ 100}{34}$ (D) $\frac{3}{34}$ 100

Q.16 The empricial formula of a compound is CH_2O. Its molecular weight is 90. Calculate the molecular formula of the compound. (Atomic weight C = 12, H = 1, O = 16)
(A) $C_3H_7O_3$ (B) $C_4H_6O_3$
(C) $C_3H_6O_3$ (D) $C_4H_2O_3$

Q.17 Calculate the weight of 2.5 mole of $CaCO_3$:-
(A) 200 g (B) 230 g
(C) 240 g (D) 250 g

Q.18 How many gram atoms are present in 256 g of O_2 ?
(A) 16 (B) 32
(C) 14 (D) 36

Q.19 How many gram atoms are present in 60 g of carbon ?
(A) 6 (B) 10
(C) 16 (D) 5

Q.20 The number of moles present in 20 grams of $CaCO_3$ is :-
(A) 0.1 (B) 0.2
(C) 0.3 (D) 0.25

Q.21 A hydrogen contain 90% of carbon and 10% hydrogen. The empirical formula of the compound is :-

(A) C_2H_5 (B) C_3H_2
(C) C_3H_4 (B) CH_3

Q.22 An element has only one type of :-

(A) Molecules (B) Atoms
(C) Mixtures (D) Solutes

Q.23 The simplest formula of a compound having 50% of X(atomic weight 10) and 50% of Y(atomic weight 20) is :-

(A) XY (B) X_2Y
(C) XY_3 (D) X_2Y_2

Q.24 How many moles of glucose ($C_6H_{12}O_6$) are present in 5.4 g ?

(A) 0.03 (B) 0.02
(C) 0.01 (D) 0.1

Q.25 Calculate the number of gram atoms present in 8 g of helium :-

(A) 3 (B) 4
(C) 2 (D) 1

Q.26 How many moles are present in 5.3 g of anhydrous sodium carbonate ?

(A) 0.03 (B) 0.04
(C) 0.05 (D) 0.01

Q.27 Calculate the number of moles present in 60 g of NaOH.

(A) 1.2 (B) 1.5
(C) 2.5 (D) 0.15

Q.28 Calculate the weight of nitrogen present in 0.5 moles of NH_3.

(A) 8 g (B) 9 g
(C) 1 g (D) 7 g

Q.29 Calculate the number of moles present in 7.3 g of HCl.

(A) 0.2 (B) 0.1
(C) 1 (D) 0.02

Q.30 Calculate the weight in gram of 0.9 gram atoms of zinc.

(A) 50.5 g (B) 58.5 g
(C) 56.3 g (D) 53.2 g

Q.31 Calculate the weight of 0.4 gram atoms of carbon.

(A) 2.8 g (B) 4.8 g
(C) 3.2 g (D) 4.0 g

Q.32 What is the weight of 3 gram atoms of sulphur?

(A) 98 g (B) 99 g
(C) 95 g (D) 96 g

Q.33 16 gram of oxygen is equal to :-

(A) 1 gram atom
(B) 0.5 gram mole
(C) 2 gram equivalents
(D) all of these

Q.34 When a neutral atom is converted into anion its :-

(A) Size increase
(B) Size decrease
(C) Atomic number increases
(D) Atomic number decreases

Q.35 Which of the following is an ionic compound?

(A) HCl (B) Na_2O
(C) CO_2 (D) SO_2

Q.36 The bond formed between two atoms of an electronegative element is :-

(A) Electrovalent (B) Covalent
(C) Coordinate (D) None of these

Q.37 Ionic compounds :

(A) Have bonds which are directional
(B) Conduct electricity in solid state
(C) do not conduct electricity in molten state
(D) Are generally more soluble in polar solvents than in nonpolar solvents

Q.38 Covalent compound commonly exhibit :-

(A) High solubilities in water
(B) Low melting points
(C) High electrical conductivity
(D) High boiling points

ANSWER KEY

1.	B	**2.**	C	**3.**	B	**4.**	A
5.	B	**6.**	C	**7.**	A	**8.**	B
9.	C	**10.**	B	**11.**	A	**12.**	C
13.	A	**14.**	D	**15.**	A	**16.**	C
17.	D	**18.**	A	**19.**	D	**20.**	B
21.	C	**22.**	B	**23.**	B	**24.**	A
25.	C	**26.**	C	**27.**	B	**28.**	D
29.	A	**30.**	B	**31.**	B	**32.**	D
33.	D	**34.**	A	**35.**	B	**36.**	B
37.	D	**38.**	B				

EXERCISE – IV OLYMPIAD QUESTIONS

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(C) Preistley (D) Ritcher

2. The weight of two elements which combine with each other are in the ratio of their :-

(A) Atomic heights (B) Atomic volumes
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3. 180 grams of water conatins _____ moles

(A) 100 (B) 10
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4. What is the weight of 3 gram atoms of sulphur

(A) 96 gm (B) 99 gm
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5. How many gram atoms are present in 144 g of magnesium ?

(A) 12 (B) 6
(C) 100 (D) 144

6. How many moles of oxygen atoms are present in one mole of acetic acid ?

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7. What is the number of particles in one mole of a substance ?

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ANSWER KEY

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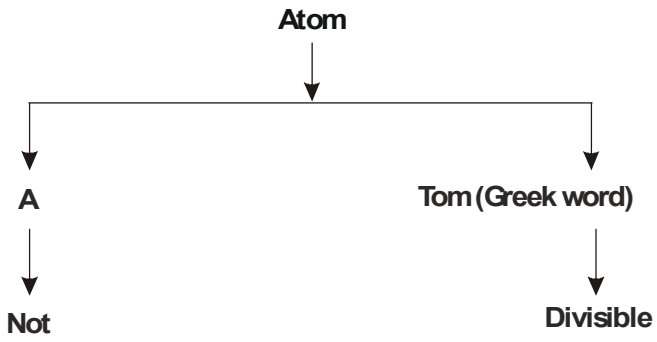
9.	C	10.	B	11.	A	12.	C
13.	A	14.	D	15.	A	16.	C
17.	A	18.	D	19.	A	20.	D
21.	B	22.	C	23.	B	24.	B
25.	A	26.	C	27.	C	28.	B
29.	D	30.	A	31.	B	32.	B
33.	D	34.	D	35.	A	36.	B
37.	D	38.	A				

STRUCTURE OF ATOM

INTRODUCTION

According to John Dalton : All matter was composed of small particle called atom.

Atom is a Greek word and its meaning **Indivisible** i.e. an ultimate particles which cannot be further subdivided.



Not divisible (According to Dalton)

According to Dalton's theory -

(1) Atom is the smallest indivisible part of matter which takes part in chemical reaction.

(2) Atom is neither be created nor be destroyed.

(3) Atoms of the same element are similar in size, mass and characteristics ; however, atoms of different elements have different size, mass and characteristics.

- **An atom is made up of three subatomic particle electron, proton & neutrons. These three particles are called fundamental particles of matter.**

Particles	Scientist	Charge	Mass
Electron (e^-)	J.J. Thomson	–ve	9.1×10^{-31} kg(1/1837=0.000599amu)
Proton(p)	E. Goldstein	+ve	1.67×10^{-27} kg
Neutron (n)	Chadwick	Zero	1.675×10^{-27} kg

DO YOU KNOW : Mass of Proton is 2000 times more than electron

ATOMIC STRUCTURE

There are two parts of atom :

(i) Nucleus (ii) Outer part

Nucleus : The size of nucleus of atom is very small in which neutrons and protons are present so the almost entire mass of the atom is situated in nucleus. Protons & neutrons present in the nucleus are collectively termed as nucleus. Number of neutrons is called mass number element. Size of the nucleus in the atom is 10^{-15}m.

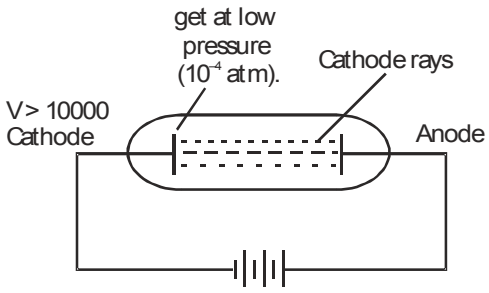
Mass number (A) = Number of protons in the nucleus (p) + Number of Neutrons (n).

Outer Part : In the outerpart, electrons move around the nucleus in fixed orbits. These orbits are called energy levels.

CATHODE RAYS

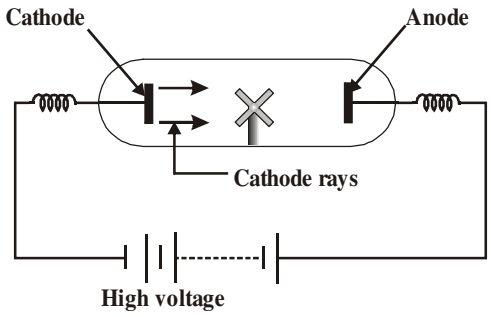
(Discovery of e^-) :

In 1859 **"Julius Plucker"** started the study of conduction of electricity through gases at low pressure in a discharge tube. When a high voltage of 10,000 volts or more was impressed across the electrodes, some sort of inversible rays moved from the negative electrodes to the positive electrode. Since the negative electrode is referred to as cathode. These rays were called cathode rays.



Properties of cathode rays :

- These rays travels in straight line away from cathode with very high velocity ranging from 10^7 to 10^9 m/sec.
- A shadow of metallic object placed in the path is cast on the wall opposite to cathode.
- Cathode rays cause green fluorescence on glass surface, i.e the glasss surface on which the cathode rays strike show a coloured shine.
- Cathode rays consist of matter particles, and posses energy by the virtue of their mass and velocity. Cathode rays set a paddle wheel into motion when it is placed in the path of these rays. This is due to the impact of the particles of the cathode rays on the blades of the paddle wheel.



Cathode ray particles strike the blades of the paddle wheel, and set it into motion

- These rays are deflected by the electric of magnetic fields when the rays are passed between two electrically charged plates, these are deflected towards the positively charged plates. It shows that cathode rays carry negative charge. These particles carrying negative charge. These particles carrying negative charge were called negatrons by thomson. The name negatron was changed "Electron by Strong".
- These rays produce heat energy when they collide with the matter. It shows that cathode rays possess kinetic energy which is converted into heat energy when stopped by matter.
- These rays affect the photographic plate.
- Cathode rays can penetrate the thin foil of solid materials.
- Cathode rays can ionize the gases through which they pass.

- The nature of cathode rays independent of

  (a) The nature of cathode

  (b) The gas in discharge tube

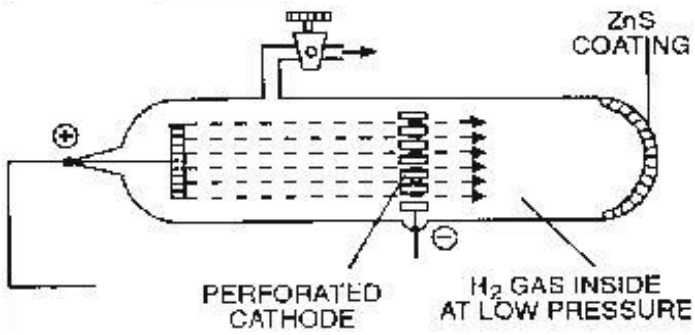
Ques. What are cathode rays ? **[NCERT]**

Measurement of e/m for electron :

In 1897 J.J. Thomson determine the e/m value, charge/mass of the electron by studying the deflection of cathode rays in electric & magnetic fields.

The value of e/m has been found to be -1.7588×10^8 coulomb/unit. The absolute value of the charge in an e^- was measured by R.A. Milikan 1909 by the Milikan's oil drops experiment.

ANODE RAYS OR CANAL RAYS



Production of Anode rays or Postive rays

It has been established that electron is a negatively charged particle present in all the atoms. As an atom is electrically neutral, there must be some positively charged particle present in the atom to neutralize the negative charge of the electrons. It has been confirmed by experiment "Goldstein" in 1886 discovered the existence of a new type of rays in discharge tube. He carrried out experiment in discharge tube containing perforated cathode. These rays moved towards cathode and passed through the perforation in the cathode.

- Initially these ray were called canal rays because they pass through the canals or holes of the cathode.
- These rays are also called anode rays since they originate from the anode side.
- Anode rays are positively charged, therefore these were named positive rays by Sir J.J. Thomson.

Characteristics of anode rays :

- Anode rays travel in straight lines. These rays rotate the light paddle wheel placed in their path. Anode rays are deflected by magnetic or electric field towards negatively charged plate. This indicates that these rays are positively charged.
- The anode rays affect photographic plate.
- The nature of anode rays depends upon the type of gas used. The charge (e) to mass (m) ratio (e/m) of anode rays particle is different for different gases. The value of e/m is maximum for hydrogen gas.
- The positive rays obtained from hydrogen are made up the same type of positive particles. These particles are known as protons.

In the discharge tube the atoms of gas lose negatively charged electrons. These atoms, thus acquire a positive charge . The positively charge particle produced from hydrogen gas were called "protons".

$$H \xrightarrow{e} H \text{ (Proton)}$$

Characteristics of proton :

A proton is a fundamental particle of atom carrying one unit positive charge of having mass nearly equal to the mass of an atom of hydrogen. The protons are present in the nucleus of the atom.

Charge of proton : Proton is a positively charged particle. The charge on a proton is equal but opposite to that on an electron. Thus the magnitude of charge on a proton is + 1.602 × 10^{-19} coulomb/unit. The mass of proton is equal to the mass of hydrogen atom.

Ques. If an atom contains one electron and one proton, will it carry any charge or not ? **[NCERT]**

THOMSON MODEL OF ATOM

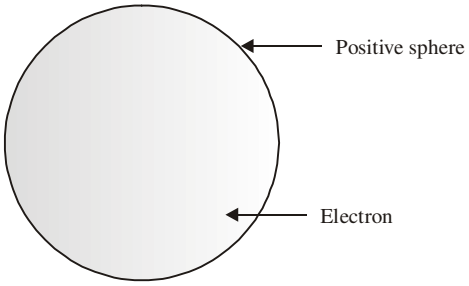


Fig. Thomson's model of the Atom

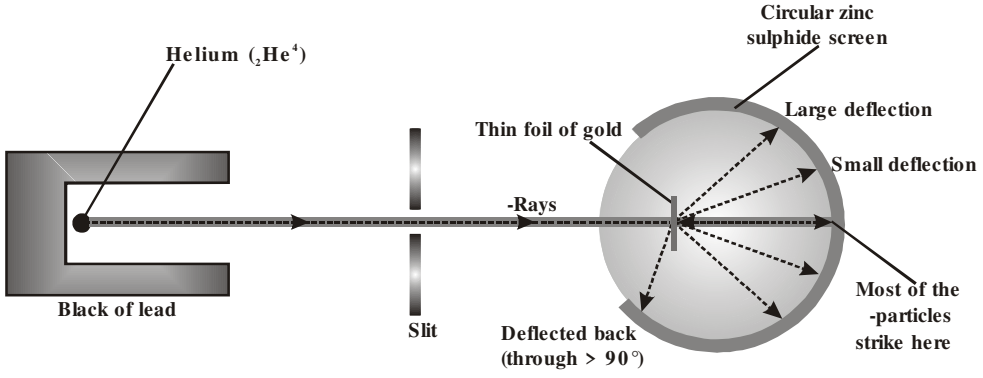
- Detailed model of the atom was first of all proposed by Sir J.J. Thomson.
- Thomson proposed that an atom consist of a uniform sphere of positive charge in which the electrons are distributed more or less uniformly.
- Thomson proposed the model of an atom to be similar to that of a Christmas pudding. The electrons, in a sphere of positive charge, were like currants (dry fruits) in a spherical Christmas pudding. We can also think of a watermelon, the positive charge in the atom is spread all over like the red edible part of the watermelon, while the electron are sudden in the positively charged sphere, like the seeds in the watermelon.

Ques. On the basis of Thomson's model of an atom, explain how the atom is neutral as a whole.**[NCERT]**

Drawback of the Thomson Model :

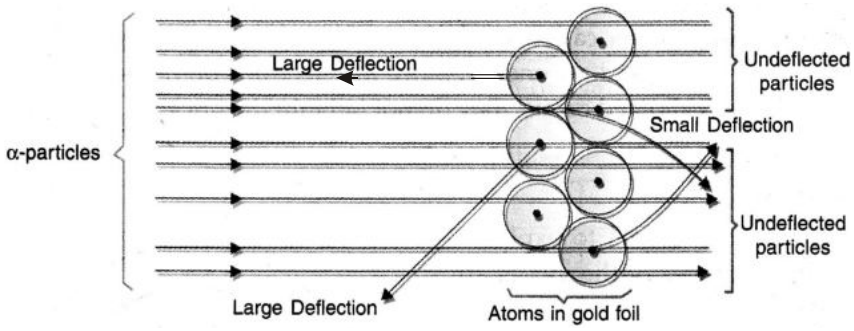
- An important drawback of this model is that the mass of the atoms is considered to be evenly spread over that atom.
- It is static model. It does not explain the movement of electron.
- It could not explain the stability of an atom.

RUTHERFORD'S MODEL OF THE ATOM (DISCOVERY OF NUCLEUS)



In 1911, scientist "Ernest Rutherford" gave a new picture for the structure of atom by his α-particle scattering experiment & proposed the structure of atom. α particle are charged particles having 2 unit of positive charge and 4 units of mass, that is α-particle (2^{He^4}) are doubly charged helium atom (He^{+2})

Rutherford Experiment :



- When fast moving alpha particles strike very thin gold foil in vaccum, it is found that **:**

  Most of the fast moving α-particles passed straight through the gold foil, without any deflection from their original part.
- Some of the α-particles were deflected by the foil by small angles and few are deflected through large angles.
- A very few alpha particles completely rebound on hitting the gold foil and turn back on their path.

Conclusion of Rutherford experiment :

Rutherford concluded from the α-particle scattering experiment that

- Most of the space inside the atom is empty because most of the α-particle passed through the gold foil without getting deflected.
- Very few particles were deflected from their path, indicating that the positive charge of the atom occupies very little space.

  A very small fraction of α-particles were deflected by 180°, indicating that all the positive charge and mass of the gold atom were concentrated in a very small volume within the atom.

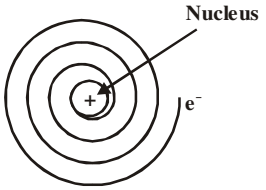
  On the basis of this experiment, Rutherford put forward the nuclear model of an atom, which has the following features.
- There is a positively charged centre in an atom called the nucleus. Nearly all the mass of the an atom resides in the nucleus.
- The electrons revolve around the nucleus in well-defined orbit.
- The size of the nucleus is very small as compared to the size of the atom.

Ques. On the basis of Rutherford's model of an atom, which subatomic particle is present in the nucleus of an atom ? **[NCERT]**

DO YOU KNOW : Radius of nucleus is 10^{-15}m radius of atom is 10^{-10}m.

Drawback of the Rutherford Experiment :

According to **Maxwell,** if an electrically charged particle revolves around circular path, then it always radiate out energy Thus. If an electron moves around the nucleus, it must continuously radiate out energy and hence, gradually more towards nucleus in a spiral path, till it collide with nucleus.



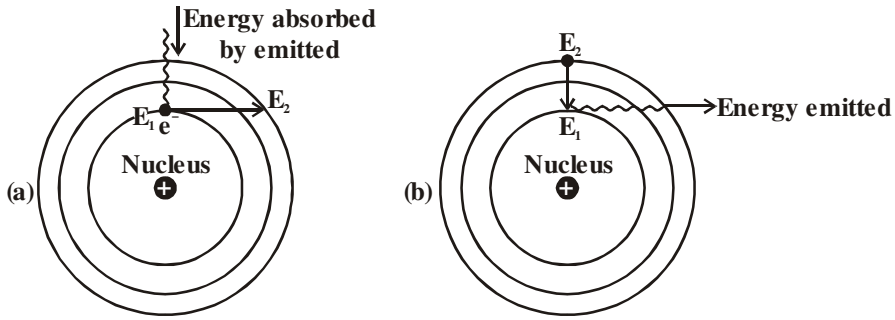
BOHR MODEL OF AN ATOM

Rutherford's Model of the atom was unable to explain certain observations with regard to the atom that is stability of the atom and the occurence of the atomic spectra.

Neil's Bohr accepted Rutherford's idea that the positive charge and most of the mass of atom is concentrated in its nucleus with the electrons present at some distance away. It is a quantum mechanical model. This model was based on quantum theory of radiation or plank theory and classical law of physics.

According to Bohr's Theory :

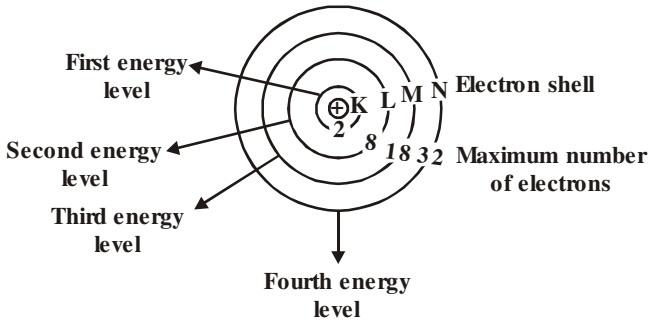
- Electrons revolve around the nucleus in well defined orbits or shells each shells having a definite amount of energy associated with the electrons in it. Therefore these shells are also called energy levels.
- The energy associated with the electrons in an orbit increase as the radius of the orbit increase. These shell also known as K, L, M, N.....starting from the one closest to the nucleus.
- An electron in a shell can move to a higher or lower energy shell by absorbing or releasing a fixed amount of energy.
- The amount of energy absorbed or emitted is given by differences energies associated with the two levels. Thus



Energy absorbed $\Delta E = E_2 - E_1 = h\nu$

Energy emitted $\Delta E = E_2 - E_1 = h\nu$

where h is plank's constant and ν is the frequency of the radiation.



Ques. Draw a sketch of Bohr's model of an atom with three shells. **[NCERT]**

DISCOVERY OF NEUTRON

In 1932, **"Chadwick "** bombarded berylium with a stream of α-particle. He observed that penerating radiations were produced which were not affected by electric & magnetic field. These radiations consists of neutral particles, which were called neutron. The nuclear reaction can be shown as as:

$${}^{9}_{4}Be + {}^{4}_{2}He \longrightarrow {}^{12}_{6}C + {}_{0}n^{1}$$

(Berylium) (α-particle) (carbon) (Neutron)

In this equation the subscript stand for number of protons and the superscript for mass number. It is now clear that the neutron is fundamental consitituent of atom and is located in the nucleus.

Characteristics of a neutron :

Mass : The relative mass of a neutron is almost equal to that of proton. In fact relative mass of neutron is 1.0087 (1.008) amu and that of proton is 1.0073 (1.008) amu.

Charge : Neutron is electrically neutral and has no electric charge. With the discovery of neutrons, we can explain why the atomic mass of helium is 4 amu. **Atomic mass = Mass of proton + Mass of neutron.**

Valency : An atom of each element has definite combining capacity of the element is called valency. The number of electron (e^-) gained, lost or shared by the atom of an element to complete octet stable :

Ex :- Ne^{20}.

Valence electron : The electron present in the outer most shell are called valence electron.

Ex. Na^+ and N^-

Ques. How will you find the valency of chlorine, sulphur and magnesium ? **[NCERT]**

ATOMIC NUMBER AND MASS NUMBER

Atomic number (Z) :

Protons are present in the nucleus of an atom. It is the number of protons of an atom, which determine its atomic number. It is denoted by 'Z'. Thus atomic number = No. of protons = No. of electrons for hydrogen Z = 1 because in hydrogen atom only one proton is present in the nucleus.

Therefore, the atomic number is defined as the total number of protons present in the nucleus of an atom.

Ex. ${}_6C^{12}$ means atomic number of carbon is 6. Nucleus of carbon has 6 protons. Nucleus of carbon has 6 unit positive charge. There are 6 electrons, revolving round the nucleus of carbon.

Ex : ${}^{24}_{12}Mg$

The mass number of magnesium is 12. The total number of protons and neutrons in the nucleus of magnesium is 24 number of protons is 12.

Number of neutrons is = 24 – 12 = 12.

Mass Number (A) : The mass number of an atom is defined as the sum of the total number of protons and neutrons present in the nucleus of an atom. For example, mass of carbon is 12u because it has 6 proton and 6 neutron that is 6u. + 6u. = 12u.

Mass number : Number of protons + number of neutron for eg.

The notation for an atom the atomic number, mass number and symbol of the element are to be written as follows.

Symbol of element : ${}_zX^A$

X ⇒ elements

A ⇒ Mass No.

Z ⇒ Atomic No.

Symbol	A	z = p	n
Li	6	3	3
C	12	6	6
N	14	7	7
O	16	8	8
Mg	24	12	12

For example-Nitrogen is written as ${}^{14}_7N$.

Ques. If number of electrons in an atom is 8 and number of protons is also 8, then (i) what is the atomic number of atom (ii) what is the charge of the atom ? **[NCERT]**

Ques. Find out the mass number of oxygen and sulphur atom. **[NCERT]**

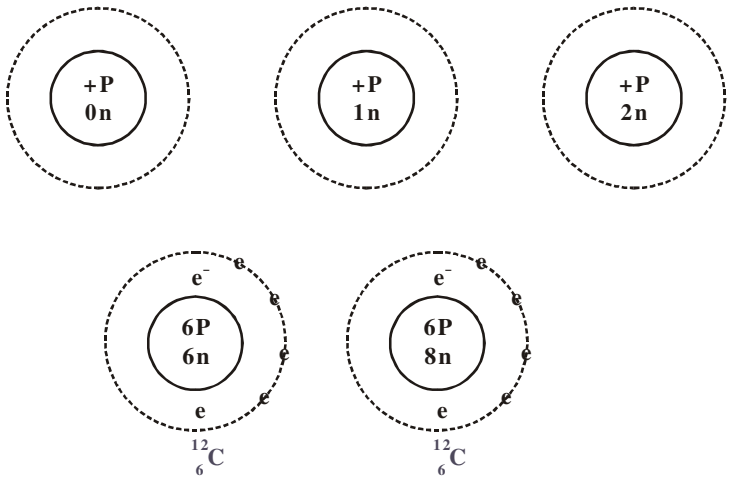
ISOTOPES

Isotopes are atoms of the same element, having the same atomic number but different mass number.

For example isotopes of hydrogen atom, namely protium ($_1H^1$) deuterium($_1H^2$) tritium ($_1H^3$).

The atomic number of each one is 1, but the mass number is 1, 2, and 3 respectively.

Exampe of Isotopes :



Isotopes of carbon $^{12}_{6}C$ and $^{14}_{6}C$

Carbon Isotopes	$^{12}_{6}C$	$^{14}_{6}C$
Atomic number	6	6
No. of protons	6	6
No. of electrons	6	6
No. of neutrons	6	8
Mass number	12	14

Applications of Isotopes :

Since the chemical properties of all isotopes of an element are the same but same isotopes have special properties which find them useful in various fields. Some of them are :

- Uranium ($^{238}_{92}U$) is used as a fuel in nuclear reactors.
- Cobalt ($^{60}_{27}Co$) is used in the treatment of cancer.
- Iodine ($^{128}_{53}I$) is used in the treatment of goitre.
- Sodium ($^{24}_{11}Na$) is used for differentiating cancerous tissues from the normal tissues.
- Carbon $^{14}_{6}C$ is used in dating of fossil samples.

How to calculate the atomic mass of an element from the mass number of its isotopes.

The atomic mass of an element is the weighted arithmetic mean of the atomic masses of its isotopes present in the sample of the element.

Let us consider a sample of an element X containing its two isotopes X_1 and X_2.

Atomic mass of the element X = $\frac{\%\text{ of } X_1 \quad \text{Mass number of } X_1 \quad \%\text{ of } X_2 \quad \text{Mass number of } X_2}{100}$

Ex. This method is illustrated by taking the case of chlorine. The two isotopes of chlorine, $^{35}_{17}Cl$ and $^{37}_{17}Cl$ occur in the ratio 3 : 1. Then,

Atomic mass of chlorine : $\frac{(35u \quad 3) \quad (37u \quad 1)}{3 \quad 1} \quad \frac{105u \quad 37u}{4} \quad \frac{142u}{4} \quad 35.5u$

Ques. If bromine occurs is in the form of say two isotopes $^{79}_{35}Br$ (49.7%) and $^{81}_{35}Br$ (50.3%), then calculate the atomic mass of bromine atom.

ISOBARS

Atoms of different elements with different atomic number which have the same mass number, are known as isobars.

For example : Calcium and argon

$$_{20}Ca^{40} \qquad _{18}Ar^{40}$$

The atomic number of argon is 18, calcium is 20 but the mass number of these element is same.

(2) $^{14}_{6}C$ and $^{14}_{7}N$

Isobars	$^{14}_{6}C$	$^{14}_{7}N$
Atomic number	6	7
No. of protons	6	7
No. of electrons	6	7
No. of neutrons	8	7
Mass number	14	14

Ques. Write the electronic configuration of any one pair of isotopes and isobars. **[NCERT]**

Order of filling of electrons in orbitals :

There are different rules for filling electrons in subshells. They are described as follows.

- Pauli's exclusion principle.
- Aufbau principle
- (n + ℓ) rule
- Hund's maximum multiplycity rule.

Pauli's Exclusion Principle :

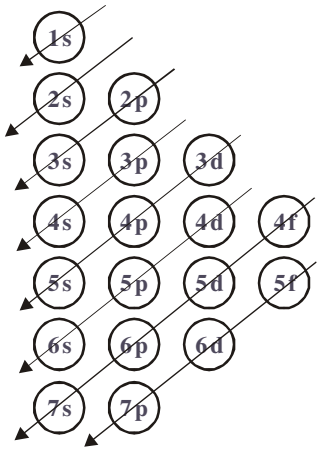
- According to **Pauli's** exclusion principle an orbital cannot accomodate more than two electrons. These two electrons should have opposite spins. eg. :

Aufbau Principle :

Aufbau is a **German word** and its meaning **building up**. Aufbau principle gives a sequence in which various subshell are filled up depending on the relative order of the energies of various subshell. The subshell with minimum energy is filled up first, when this subshell obtained maximum no. of e^- or capacity of electrons then the next subshell of higher energy starts fillings.

The order of filling of different sub-shell in represented diagramatically as follows :

Simmon's Array :



Hund's Maximum Multiplicity Rule :

According to hund's rule electrons are distributed among the orbitals of subshell in such a way to give maximum number of unpaired electron with parallel spin.i.e. in a subshell pairing of electons will not start until and unless all the orbitals of that subshell will get one electron each with same spin.

For example :

$_7N$	$1s^2$	$2s^2$	$2p^3$
	☐	☐	☐☐☐
$_8O$	$1s^2$	$2s^2$	$2p^4$
	☐	☐	☐☐☐

(n + ℓ) Rule : According to it the sequence in which various subshells are filled up can also be determined with the help of (n + ℓ) value for a given subshell. The subshell with lowest (n + ℓ) value is filled up first when two or more subshells have same (n + ℓ) value then the subshell with lowest value of n is filled up first.

Sub Shell	n	ℓ	n +ℓ	
1s	1	0	1	
2s	2	0	2	
2p	2	1	3	(1)
3s	3	0	3]	(2)
3p	3	1	4	(1)
4s	4	0	4]	(2)
3d	3	2	5	(1)
4p	4	1	5	(2)
5s	5	0	5]	(3)
4d	4	2	6	(1)
5p	5	1	6	(2)
6s	6	0	6]	(3)

ELECTRONS DISTRIBUTION IN DIFFERENT ORBIT (SHELL)

The distribution of electron into different orbits of an atom was suggested by Bohr and Bury. The following rules are followed for writing the number of electrons in different energy level or shell. The maximum number of electrons present in a shell is given by the formula **$2n^2$.** Where 'n' is the orbit number or energy level index 1,2,3. Hence the maximum number of electrons in different shells are as follows.

First orbit (K-shell)

$2 \times 1^2 = 2$

Second orbit (L-shell) = $2 \times 2^2 = 8$

Third orbit (M-shell) = $2 \times 3^2 = 18$

Fourth orbit (N-shell) = $2 \times 4^2 = 32$

The maximum number of electrons that can be accommodated in the outermost orbit is 8.

- Electron are not accommodated in a given shell. unless the inner shell are filled. That is, the shell are filled in a step-wise manner.

Orbitals : The three dimensional area around the nucleus of an atom where the probability of finding the moving electrons is maximum is called orbital.

ROUND UP

- Discharge tube studies by J.J. Thomson and other led to the discovery of electron.
- J.J. Thomson determined the value of charge/ mass ratio, e/m of the electron.
- R.A. Millikan determined the value of charge on the electron.
- Positive rays were discovered by E. Goldstein and these are also called **canal rays.**
- Rutherford and his co-workers performed α-particle scattering experiments which led to the discovery of **atomic nucleus.**
- Atoms of the same element which have the same atomic number but different mass number are called **isotopes.**
- Atoms of different elements having same mass number but different atomic number are called **isobars.**
- Bohr's model of an atom gave the concept of **orbits or shells.** These are designeted as K, L, M, N,
- Each orbit has a definite energy and that is why these are also called **energy levels or energy shells.**
- Neutron was discovered by Chadwick.
- The number of protons in an atom of an element is known as **atomic number.**
- The sum of the number of protons and neutrons in an atom of the element is called **mass number**.
- In general, the maximum number of electrons that can be present in any shell is **$2n^2$** where n *is* the number of energy shell.
- The distribution of electrons in different energy shells is called **electronic configuration.** Electronic configuration of atoms are written with the help of **K, L, M,** etc.
- The electrons present in the outermost orbit (or valence shell) are called **valence electrons.**
- The valency of atom is either no. of electrons in valence shell or 8 – no. of electrons in the valence shell.

NCERT QUESTIONS WITH SOLUTIONS

Q.1 What are canal rays?

Ans. The anode rays are also called canal rays because anode rays were passed through perforated cathode/hole which were called canal by Goldstein. Therefore, he named these rays as canal rays.

Q.2 If an atom contains one electron and one proton, will it carry any charge or not?

Ans. No, the atom will be neutral as the negative charge of one electron is cancelled out by the positive charge of one proton. So, the resultant charge will be zero.

Q.3 On the basis of Thomson's model of an atom, explain how the atom is neutral as a whole.

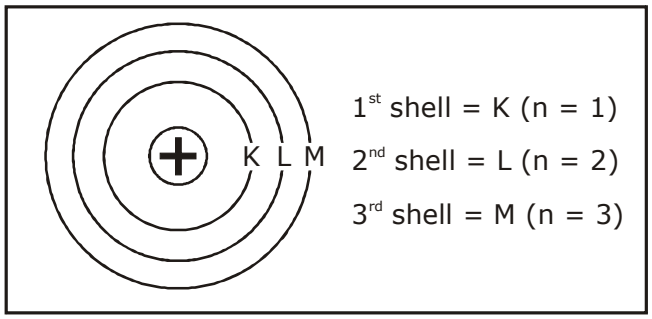
Ans. According to Thomson's atomic model, the embeded electrons are equal to the positive charge on sphere, so net charge on the atom is zero.

Q.4 On the basis of Rutherford's model of an atom, which sub-atomic particle is present in the nucleus of an atom?

Ans. Protons are the sub-atomic particles which are present in the nucleus on the basis of Rutherford's model of an atom.

Q.5 Draw a sketch of Bohr's atomic model with three shells.

Ans.



Q.6 What do you think would be the observation if the α-particle scattering experiment is carried out using a foil of metal other than gold?

Ans. If α-particles scattering experiment is carried out with other metals, i.e., heavy metals like platinum or silver then experiment may be almost same as that with gold. But if lighter metals are taken then the α-particles may knock out the nulceus and they may not be returned back or deflected.

Q.7 Name the three sub-atomic particles of an atom.

Ans. The sub-atomic particles are electrons, protons and neutrons.

Q.8 Helium atom has an atomic mass of 4 u and two protons in its nulceus. How many neutrons does it have?

Ans. Atomic mass = 4, Number of protons = 2 = Atomic number
So, number of neutrons = Mass number – Atomic number = 4 – 2 = 2

Q.9 Write the distribution of electrons in carbon and sodium atoms.

Ans. **For carbon atom:** Atomic number = 6
Thus total number of electrons = 6
Hence, K = 2, L = 4.
For sodium atom: Atomic number = 11
Total number of electrons = 11
Thus K = 3, L = 8, M = 1

Q.10 If K and L shells of an atom are full, then what would be the total number of electrons in the atom?

Ans. Maximum number of electrons in K shell = $2 \times 1^2 = 2$
Maximum number of electrons in L shell = $2 \times 2^2 = 8$
Hence, total number of electrons = 2 + 8 = 10

Q.11 How will you find the valency of chlorine, sulphur and magnesium?

Ans. Atomic number of chlorine = 17

		K	L	M
∴	Electronic configuration	2	8	7

Valency = 8 – 7 = 1
Atomic number of sulphur = 16

		K	L	M
∴	Electronic configuration	2	8	6

Valence electrons = 6
∴ Valency = 8 – 6 = 2
Atomic number of magnesium = 12

		K	L	M
∴	Electronic configuration =	2	8	2

Valence electrons = 2
∴ Valency = 2

Q.12 If number of electrons in an atom is 8 and number of protons is also 8, then:
(a) What is the atomic number of the atom? and
(b) What is the charge on the atom?

Ans. (a) Atomic number = Number of protons = 8
(b) The given atom has equal number of proton and electrons. So, net charge will be zero and the atom will be neutral.

Q.13 For the symbol H, D and T, tabulate three sub-atomic particles found in each of them.

Ans. The three isotopes of hydrogen which can be represented as ${}_1^1H$, ${}_1^2D$, ${}_1^3T$.

H (Proteium),	Atomic number = 1
	Mass number = 1
	Number of neutrons = A – Z = 1 – 1 = 0
D (Deutrium),	Atomic number = 1
	Mass number = 2
	Number of neutrons = A – Z = 2 – 1 = 1
T (Tritium),	Atomic number = 1
	Mass number = 3
	Number of neutrons = A – Z = 3 – 1 = 2

Q.14 What are the limitations of Rutherford's model of the atom?

Ans. Limitations of Rutherford's atomic model are:
He could not explain the stability of the atom, as he described that electrons revolve around the nucleus under the influence of positive charge of the nucleus. But according to electron dynamics when a charged particle revolves around the opposite charge, its speed accelerates and it loses the energy and collapses.

Q.15 What are the limitations of J.J. Thomson's model of the atom?

Ans. The limitations of Thomson's atomic model are:
(a) He could not explain the results of Rutherford's alpha particle experiment.
(b) He could not explain the spectral properties of the atom.

Q.16 Write the electronic configuration of any one pair of isotopes and isobars.

Ans. Isotopes pair $^{35}_{17}C$ and $^{37}_{17}Cl$

They are the isotopes having same atomic number, so, they will have same electronic configuration:

=	K,	L,	M
	2	8	8

Pair of isobars = $^{40}_{18}Ar$, $^{40}_{20}Ca$,

As isobars have same mass number but different atomic number therefore, they will have different electronic configuration,

Ar(Z = 18)	=	K,	L,	M
		2,	8,	8
Ca(Z = 20)	=	K,	L,	M, N
		2,	8,	8, 2

Q.17 Compare the properties of electrons, protons and neutrons.

Ans.

S.No.	Parameter	Electron	Proton	Neutron
1	Notation	e^-	p^+ or p	n
2	Location	Outside the nucleus	Inside the nucleus	Inside the nucleus
3	Absolute charge	$-1.602 \times 10^{-19}C$	$+1.602 \times 10^{-19}C$	0
4	Relative charge	−1	+1	0
5	Absolute mass	$9.1 \times 10^{-31}Kg$	$1.673 \times 10^{-27}Kg$	1.675×10^{-27} Kg
6	Relative mass	1/1840 times of H atom	Equal to H atom	Equal to H atom
7	e/m ratio	$1.76 \times 10^{8}C/g$	9.58×10^{4} C/g	––

Q.18 Describe Bohr's model of the atom.

Ans. Neils Bohr proposed his model in 1913 in order to overcome the shortcomings of Rutherford's model. He gave the concept of orbits, discrete states or energy levels.

Q.19 Compare all the proposed models of an atom given in this chapter.

Ans.

Parameters	Thomson's model	Rutherford's model	Bohr's model
Location of Positive charge	Positive charge is uniformly distributed inside the atom	Positive charge located inside the nucleus	Positive charge located inside the nucleus
Location of negative charge	Negatively charged electrons embeded into the sphere	Electrons moving around the nucleus	Electrons moving around the nucleus in certain fixed orbit
Nature of atom	Neutral	Neutral	Neutral
Location of mass	Uniformly distributed	The entire mass of an atom is concentrated at the centre of the atom	The entire mass of an atom is concentrated in the nucleus

Q.20 Define valency by taking examples of silicon and oxygen.

Ans. The combining capacity of an element is called its valency or the number of electrons lost, gained or shared by an atom during bond formation or chemical combination is called its valency.

For example, silicon (Z = 14)

Electronic configuration, K, L, M

2, 8, 4

So, the valency = 4, as the last shell (valency shell) has 4 electrons.

Oxygen (Z = 8)

Electronic configuration– K, L

2, 6

The last shell or valence shell has 6 electrons, it will take 2 electrons to complete its octet, therefore the valency is 2.

Q.21 Explain with examples

(i) Atomic number (ii) mass number

(iii) Isotopes (iv) Isobars

Give any two uses of isotopes.

Ans. (i) Atomic number(Z): The number of protons present in the nucleus of an atom represents its atomic number.

For example, $^{32}_{16}S$ Sulphur has 16 protons in its nucleus, its atomic number is 16.

(ii) Mass number: Mass number(A) is the sum of number of protons and number of neutrons.

A = Number of protons + Number of neutrons

A = Z + n

For example, In aluminium, the nucleus has 13 protons and 14 neutrons,

therefore, the mass number = 13 + 14 = 27

(iii) Isotopes: They are the atoms of same elements which have same atomic number but different mass number. The difference in mass number is due to the difference in number of neutrons.

For example, chlorine has two isotopes $^{35}_{17}Cl$ and $^{37}_{17}Cl$.

(iv) Isobars: They are the atoms of different elements which have same mass number but different atomic number, therefore, they have different physical and chemical properties.

For example, $^{40}_{18}Ar$ and $^{40}_{20}Ca$

Uses of Isotopes:

(i) Iodine –131 is used in treatment of thyroid cancer.

(ii) C – 14 is used in estimation of age of fossils.

Q.22 Na^+ has completely filled K and L shells. Explain.

Ans. Atomic number of sodium = 11

Electronic configuration = K, L, M

2 8 2

Sodium atom loses one electron to form Na^+ ion.

As we know that K is the first shell and maximum electrons in 1st shell = $2 \times 1^2 = 2$

L is 2nd shell and the maximum electrons in 2nd shell = $2 \times 2^2 = 8$ electrons

Electronic configuration of Na^+ is 2, 8. So, we find out the K and L shell of Na^+ is completely filled.

Q.23 If bromine atom is available in the form of, say, two isotopes – $^{79}_{35}Br$ (49.7%) and $^{81}_{35}Br$ (50.3%), calculate the average atomic mass of bromine atom.

Ans. Given % of Br - 79 = 49.7%, Br - 81 = 50.3%

$$\therefore \text{ Average atomic mass} = \frac{(79 \times 49.7) + (81 \times 50.3)}{100}$$

$$= \frac{3926.3 + 4074.3}{100} = 80.006\text{u or amu.}$$

Q.24 The average atomic mass of a sample of an element X is 16.2 u. What are the percentages of isotopes $^{16}_{8}X$ and $^{18}_{8}X$ in the sample?

Ans. Given, average atomic mass = 16.2u, Isotopes = X - 16, X - 18
Let the percentage of X – 16 isotope be x% and that X – 18 isotope is (100 – x)%

$$\therefore \text{ Average atomic mass} = \frac{16 \times x + 18(100 - x)}{100} = 16.2$$

$$\Rightarrow \frac{16x + 1800 - 18x}{100} = 16.2$$

$$= 1800 - 2x = 1620$$

$$\Rightarrow -2x = -180$$

$$x = 90\% \text{ of X-16 isotope}$$

$$\therefore \text{ \% of X-18 isotope} = 100 - 90 = 10\%$$

Q.25 If X = 3, what would be the valency of the element? Also, name the element.

Ans. Given Z = 3, the element is Li (lithium).
Now electronic configuration = K, L
2, 1
The last shell or the valence shell has 1 electron.
The valency = 1+

Q.26 Composition of the nuclei of two atomic species X and Y are given below:

		X	Y
Protons	=	6	6
Neutrons	=	6	8

Give the mass numbers of X and Y. What is the relation between the two species?

Ans. According to the given composition:
Mass number = Number of protons + Number of neutrons
Mass number of X = 6 + 6 = 12
Mass number of Y = 6 + 8 = 14
These are isotopes of each other because they have same atomic numbers but different mass number.

Q.27 For the following statements, write (T) for true and (F) for false.
(a) J.J. Thomson proposed that the nucleus of an atom contains only nucleons.
(b) A neutron is formed by an electron and a proton combining together. Therefore, it is neutral.
(c) The mass of an electron is about 1/1840 times that of proton.
(d) An isotope of iodine is used for making of tincture iodine which is used as a medicine.

Ans. (a) F, as it was not stated by Thomson.
(b) F, as neutrons are separate particles.
(c) T, as this was proved experimentally.
(d) F, as the iodine (I-131) is radioactive and costly, so, only simple iodine (I-127) and alcohol is used in tincture of iodine.

EXERCISE – I

Q.1 The first use of quantum theory to explain the structure of atom was made by –

(A) Heisenberg (B) Bohr

(C) Plank (D) Einstein

Q.2 Plum-Pudding model is known as–

(A) Rutherford Model

(B) Thomson's model

(C) Bohr Model

(D) All the above

Q.3 Nucleous consist of–

(A) Proton and electron

(B) Proton and neutron

(C) Neutron and electron

(D) Only neutron

Q.4 The number of valence electron in Na is –

(A) 1 (B) 2

(C) 3 (D) 4

Q.5 Mass number of element is –

(A) Number of protons in its nucleus

(B) Number of electrons and protons in the atom

(C) Number of neutrons and protons in the nucleus

(D) Number of neutrons in the nucleus

Q.6 According to the Dalton's atomic theory –

(A) Electrons, proton and neutron are found in atom

(B) Atom is indivisible

(C) Atom of various element have same properties

(D) Atoms are destroyed in the chemical reaction

Q.7 Neutron is a fundamental particle which have–

(A) +1 unit charge and 1 unit mass

(B) No charge and 1 unit mass

(C) Have no charge and mass

(D) Have –1 unit charge and 1 unit mass

Q.8 No. of unpaired electron in $1s^2.2s^2.2p^4$

(A) 4 (B) 2

(C) 0 (D) 1

Q.9 The electron should be filled in the orbital in accordance with the increasing order of their energy. This statement is related with –

(A) AUfbau principle (B) Pauli principle

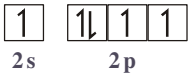
(C) Hund's principle (D) Plank's rules

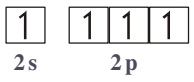
Q.10 Which species does not contain neutron –

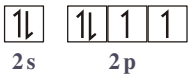
(A) H (B) Li^{+2}

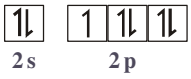
(C) C (D) o

Q.11 Which of the following electronic configuration does obey aufbau principle –

(A) 

(B) 

(C) 

(D) 

Q.12 Atomic number of any element–

(A) Atomic weight divided by two

(B) Number of neutron in nucleus

(C) Nucleus weight

(D) Nuclear charge

Q.13 Lighest particle is –

(A) Neutron (B) Electron

(C) Proton (D) None of these

Q.14 Fundamental particle of atomic nucleus is–

(A) p, e^- (B) p, n, e

(C) p, n (D) n, e

Q.15 The atomic size is nearly –

(A) 10^{-10}cm (B) 10^{-6}m

(C) 10^{-7}m (D) 10^{-10}m

Q.16 An atom which has a mass number of 14 or 8 neutrons is–

(A) Isotope of oxygen

(B) Isotope of oxygen

(C) Isotope of carbon

(D) Isobar of carbon

Q.17 Electronic configuration of p in ground state is–

(A) $1s^2 2s^2 2p^6$

(B) $1s^2 2s^2 2p^6 3s^2 3p^3$

(C) $1s^2 2s^2 2p^6 3s^2 3p^2 3d^1$

(D) $1s^2 2s^2 2p^6 3s^2$

Q.18 When a gas at reduced pressure is subjected to an electric discharge, the rays orignating from the negative electrode are–

(A) Anode rays (B) Cathode rays

(C) x-rays (D) Radiation ray,

Q.19 The maximum number of electrons that can be accomodate in the n^{th} level is–

(A) n^2 (B) $2n^2$

(C) $4n^2$ (D) n

Q.20 Isotopes of an element are the atom which have –

(A) The same number of neutrons in their nuclei

(B) The same mass number

(C) Different number of electrons in their orbit

(D) The same number of proton in their nuclei

Q.21 Number of valence electron in Ar are–

(A) 8 (B) 18

(C) 19 (D) 20

Q.22 Rutherford's alpha-particle Scattering experiment was responsible for the discovery of–

(A) Proton (B) Electron

(C) Neutron (D) Atomic nucleus

Q.23 Isotopes of an elements have –

(A) different chemical properties

(B) different atomic

(C) The same physical properties

(D) Different number of neutrons

Q.24 Which one of the following is a correct electronic configuration of calcium–

(A) 2, 8, 8, 1 (B) 2, 6, 8, 2

(C) 2, 8, 8, 2 (D) 2, 8, 2, 8

Q.25 Which one of the following is a correct electronic configuration of chromium–

(A) 2, 8, 8, 6 (B) 2, 8, 8, 2, 4

(C) 2, 8, 8, 1,5 (D) 2, 8, 8, 2, 5

Q.26 $^{35}_{17}Cl$ and $^{37}_{17}Cl$ differ from other in number of

(A) Electron (B) Proton

(C) Neutron (D) A & C

Q.27 $^{40}_{18}Ar$ and $^{40}_{20}Ca$ have the same number of

(A) Electron (B) Proton
(C) Nucleons (D) A & C

Q.28 The total number of neutrons in zinc (z = 30) with mass number 70 is -

(A) 40 (B) 20
(C) 36 (D) 38

Q.29 The sum of number of neutron and protons in one of the isotopes of hydrogen is-

(A) 3 (B) 2
(C) 5 (D) 6

Q.30 Deflection back of a few particles on hitting thin foil of gold shows that-

(A) Nucleus in heavy

(B) Nucleus in small

(C) Both (1) and (2)

(D) Electron create hinderance in the movement of α-particles.

Q.31 The number of electrons in the M-shell of the element with atomic number 24 is -

(A) 24 (B) 12
(C) 13 (D) 8

Q.32 Electronic configuration violated

(A) Hund's rule (B) Pauli's rule
(C) Aufbau rule (D) All of the above

Q.33 Number of unpaired electron in $1s^2 2s^2 2p^4$

(A) 4 (B) 2
(C) 0 (D) 1

Q.34 Electronic configuration of Cr is -

(A) (Ne) $3s^2\ 3p^6\ 3d^4\ 4s^2$
(B) (Ne) $3s^2\ 3p^6\ 3d^5\ 4s^1$

(C) (Ne) $3s^2\ 3p^6\ 3d^3\ 4p^1$
(D) (Ne) $3s^2\ 3p^6\ 4s^1\ 4p^3$

Q.35 Which electronic configuration is most stable

(A) $3d^2\ 45°$ (B) $3d°\ 4s^1$
(C) $3d^1\ 4s^0$ (D) $3d^5\ 4s^1$

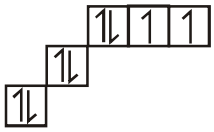
Q.36 Which rule is not followed by configuaration

(A) Hunds rule (B) Aufbau rules
(C) n + ℓ rules (D) All of the above

Q.37 Difference between Cl a atom and Cl^- ion of -

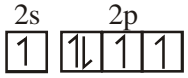
(A) Proton (B) Electron
(C) Neutron (D) Proton and electron

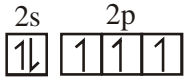
Q.38 Which element is represented by the following electronic configuration ?

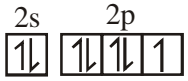


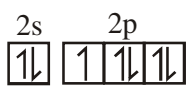
(A) Nitrogen (B) Oxygen
(C) Flourine (D) Neon

Q.39 Which of the following electronic configuration does not obey aufbau principal.

(A) 

(B) 

(C) 

(D) 

Q.40 $_{18}Ar^{40}$, $_{19}K^{40}$, $_{20}Ca^{40}$

(A) Isotopes (B) Isobars
(C) A & B both (D) None

Q.41 Electronic configuration of Fe^{+2} is -

(A) (Ar) $4s^2$ $3d^6$ (B) (Ar) $3d^6$
(C) (Ar) $4s^2 3d^4$ (D) (Ar) $4s^2 3d^0$

Q.42 The charge and mass of the proton present in the nucleus of helium atom are respectively-

(A) +2, 4u (B) +1, 1u
(C) +2, 1u (D) +2, 2u

Q.43 Which of the following is not correct observation/conclusion from Rutherford scattering experiment-

(A) Nucleus is small but heavy

(B) Nucleus always carries positive charge

(C) Atom is nearly 10^5 times greater than the size of the nucleus

(D) The number of α-particle hiting the nucleus is very large.

Q.44 Neutron is present in all atom except-

(A) Protium (B) Deuterium
(C) Tritium (D) Helium

Q.45 A monovalent anions has 10 electrons and 10 neutrons. The atomic number and mass number of the element are respectively-

(A) 10, 20 (B) 9, 18
(C) 10, 20 (D) 9, 19

Q.46 A trivalent cation of an element contains 10 electrons. The atomic number of the element is-

(A) 10 (B) 7
(C) 13 (D) None of these

Q.47 Which of the following isotope is used in the treatment of blood cancer -

(A) P-32 (B) I-131
(C) Co-60 (D) Any one of these

Q.48 Which isotope is generally used as a nuclear fuel-

(A) U-235 (B) Co-60
(C) P-32 (D) Iodine

Q.49 Which isotope is used in treatment of cancer ?

(A) Co-60 (B) U-235
(C) P-32 (D) Iodine

ANSWER KEY

1.	B	**2.**	B	**3.**	B	**4.**	A
5.	C	**6.**	B	**7.**	B	**8.**	B
9.	A	**10.**	A	**11.**	C	**12.**	D
13.	B	**14.**	C	**15.**	A	**16.**	C
17.	B	**18.**	B	**19.**	B	**20.**	D
21.	A	**22.**	D	**23.**	D	**24.**	C
25.	C	**26.**	C	**27.**	C	**28.**	A
29.	D	**30.**	C	**31.**	C	**32.**	D
33.	B	**34.**	B	**35.**	D	**36.**	D
37.	B	**38.**	B	**39.**	A	**40.**	B
41.	C	**42.**	A	**43.**	D	**44.**	A
45.	D	**46.**	C	**47.**	A	**48.**	A
49.	A						

EXERCISE – II

FILL IN THE BLANKS:

Q.1 Electron are .....charged particle.

Q.2 The scientist who discovered the nucleus is .....

Q.3 Neutron have mass equal to .....but have .....electric charge.

Q.4 $^{12}_{6}C$ contain.....protons and .....neutrons.

Q.5 The atomic number is equal to the number of .....protons.

Q.6 An element has mass number 23, its atomic number is 11, the number of neutrons will be equal to .....

Q.7 Isotopes have same .....

Q.8 Isobars have same number of .....

Q.9 The charge on the atom containing 17 protons, 18 neutrons and 18 electrons is .....

Q.10 Neutrons are not present in .....?

Q.11 $_{17}Cl^{35}$ and $_{17}Cl^{37}$ are .....?

Q.12 The maximum number of electrons that can be presented in the outermost shell an atom is.

Q.13 The total number of protons and neutrons in the nucleus of an atom is called its .....

Q.14 The fundamental particles of an atom are.....and.....

Q.15 Protons were discovered by .....and electron.....and neutrons by.....

Q.16 What is the valency of fluorine.....

Q.17 Alpha-particle scattering experiment was responsible for the discovery of.....

TRUE OR FALSE :

Q.1 Element having electronic arrangement 2, 8, 8,1,9 is Cu.

Q.2 Element having electronic arrangement 2, 8, 8, 1, 5 in chromium.

Q.3 In Na^+ number of e^- are more than the number of protons.

Q.4 Isotopes of iodine is used for making tincture of iodine in medicine.

Q.5 Neutron is sum of proton plus electron and therefore, it is neutral.

Q.6 Isobar of an element different in the number of neutron.

Q.7 Neutron were discovered by Hency Becqueral.

Q.8 Helium does not neutron.

Q.9 Hydrogen does not have neutron.

Q.10 The valency of potassium is 2.

Q.11 J.J. Thomson proposed that the nucleus of an atom contain only nucleons.

Q.12 A neutron is formed by an electron and a proton combining together. There, it is neutral.

Q.13 The mass of an electron is about $\frac{1}{2000}$ times that of proton.

Q.14 An isotoope of iodine is used for making tincture iodine, which is used as a medicine.

ANSWER KEY

FILL IN THE BLANKS

1.	–ve	**2.**	Rutherford
3.	Proton, No	**4.**	6, 6
5.	Proton	**6.**	12
7.	Atomic number		
8.	Atomic mass	**9.**	–ve
10.	Hydrogen	**11.**	Isotopes
12.	8 Electron	**13.**	Atomic mass
14.	e,p and n		
15.	Goldstein , JJ Thomson, Chadwick		
16.	7	**17.**	Nucleus

True & False

1.	F	**2.**	T	**3.**	F	**4.**	T
5.	T	**6.**	T	**7.**	F	**8.**	F
9.	T	**10.**	F	**11.**	F	**12.**	T
13.	T	**14.**	T				

EXERCISE – III

Q.1 Metals and hydrogen are always :-
(A) Electropositive
(B) Electronegative
(C) Both A and B
(D) None of the above

Q.2 Mg^{+2} and F^{-} ions differ in which of the following fundamental particles ?
(A) Electrons, protons and neutrons
(B) Protons and neutrons
(C) Only protons
(D) Neutrons and electrons

Q.3 Valency of iron in $FeCl_2$ and $FeCl_3$ is _____ and _____ respectively
(A) 1, 2 (B) 2, 1
(C) 2, 3 (D) 3, 2

Q.4 Valency of tin in $SnCl_2$ and $SnCl_4$ is _____ and _____ respectively
(A) 2, 4 (B) 4, 2
(C) 3, 4 (D) 2, 3

Q.5 Valency of tin in SO_2 and SO_3 is _____ and _____ respectively
(A) 3, 6 (B) 2, 3
(C) 2, 6 (D) 4, 6

Q.6 The charge carried by an electron is :-
(A) 1.602×10^{19} coluombs
(B) 1.602×10^{-19} coluombs
(C) 1.609 coluombs
(D) 6.02×10^{19} coluombs

Q.7 Which of the following electronic configuration is wrong ?
(A) Be (3) = 2, 1
(B) O (8) = 2, 6
(C) S (16) = 2, 6, 8
(D) P (15) = 2, 8, 5

Q.8 The mass of a proton is :-
(A) 1.609 g (B) 1.6×10^{24} g
(C) 1.6×10^{-23} g (D) 1.6×10^{-24} g

Q.9 Which of the following electronic configuration represents a noble gas ?
(A) 2, 8, 2 (B) 2, 8, 6
(C) 2, 8 (D) 2, 8, 8, 2

Q.10 The e/m is not constant for :-
(A) Cathode rays (B) Positive rays
(C) α-rays (D) β-rays

Q.11 Size of the nucleus is :-
(A) 10^{-15} cm (B) 10^{-13} cm
(C) 10^{-10} cm (D) 10^{-8} cm

Q.12 Nucleus model of the atom was proposed by :-
(A) Thomson (B) Neils Bohr
(C) Moseley (D) Rutherford

Q.13 Cathode rays have :-
(A) Only mass
(B) Only charge
(C) Neither mass nor charge
(D) Both mass and charge

Q.14 Which of the following is false ?
(A) Neutron has highest mass among fundamental particles
(B) The mass of an electron is negligible
(C) e/m is highest for a proton
(D) Charge of neutron is zero

Q.15 The ratio of specific charge of α proton and a particle is :-
(A) 2 : 1 (B) 1 : 2
(C) 1 : 4 (D) 1 : 1

Q.16 Which of the following particles is the heaviest?
(A) Meson (B) Electron
(C) Proton (D) Neutron

Q.17 A species 'X' contains 9 protons, 10 electrons and 11 neutrons. It is :-
(A) A neutral atom (B) An isotope
(C) A cation (D) An anion

Q.18 Bohr's atomic theory gave the idea of :-
(A) Quantum numbers
(B) Shape of sublevels
(C) Nucleus
(D) Stationary states

Q.19 Energy of an orbit :-
(A) Increases as we move away from the nucleus
(B) Remains same as we move away from the nucleus
(C) Decreases as we move away from the nucleus
(D) None of the above

Q.20 According to Bohr's model of hydrogen atom :-

(A) The linear velocity of the electron is quantised

(B) The angular velocity is quantised

(C) The linear momentum of the electrons is quantised

(D) The angular momentum of the electron is quantised

Q.21 If three neutrons are added to the nuclei of $_{92}U^{235}$, the new nucleus will have an atomic number of :

(A) 89 (B) 95
(C) 90 (D) 92

Q.22 Oxygen atom and oxide ion have :-

(A) Same size
(B) Same electron number
(C) Same electronic configuration
(D) Same proton number

Q.23 Which of the following statement is true ?

(A) F^- has more electrons than Na^+
(B) F^- has less electrons than Na^+
(C) Na^+ and F^- has equal electrons
(D) None of the above

Q.24 Which of the following ions is the smallest in size ?

(A) Mg^{2+} (B) Na^+
(C) O^{2-} (D) F^-

Q.25 The maximum number of electrons that can be accommodated in the 4^{th} energy level is :-

(A) 32 (B) 18
(C) 2 (D) 8

Q.26 Size of an atoms is expressed in terms of :-

(A) Atomic radius
(B) Vander Waals radius
(C) Ionic radius
(D) Either A or B

Q.27 The metals of s-block elements combine directly with halogens (X) at appropriate temperature to form halides of the :-

(A) MX and MX_2 type
(B) MX_2 and MX_3 type
(C) MX_3 and MX_4 type
(D) MX and MX_3 type

Q.28 The total number of electrons in a nitrogen atom and chlorine atom is 7 and 17 respectively. Find the number of valence electrons in them :-

(A) 3, 1 (B) 5, 8
(C) 4, 1 (D) 5, 7

Q.29 Name the element having two electrons in the K shell of its atom :-

(A) Hydrogen (B) He^+
(C) Helium (D) None of these

Q.30 Isotopes differ in :-

(A) Physical properties
(B) Chemical properties
(C) Number of protons
(D) None of these

Q.31 $_5B^{10} + _2He^4 \rightarrow X + _0n^1$ 'X' in the above reaction is :-

(A) $_7N^{12}$ (B) $_7N^{13}$
(C) $_6B^{13}$ (D) None of these

Q.32 On the bombardment of $_7N^{14}$ with α-particles, the nucleus of the product after the release of a proton will be :-

(A) $_8O^{17}$ (B) $_8O^{18}$
(C) $_9F^{17}$ (D) $_9F^{18}$

Q.33 The isotope used for dating archaeological findings is :-

(A) $_1H^3$ (B) $_6C^{14}$
(C) $_8O^{18}$ (D) $_{92}U^{235}$

ANSWER KEY

1.	A	**2.**	B	**3.**	C	**4.**	A
5.	D	**6.**	B	**7.**	C	**8.**	D
9.	C	**10.**	B	**11.**	A	**12.**	D
13.	D	**14.**	A	**15.**	B	**16.**	C
17.	D	**18.**	A	**19.**	A	**20.**	D
21.	D	**22.**	D	**23.**	C	**24.**	A
25.	A	**26.**	A	**27.**	A	**28.**	D
29.	C	**30.**	A	**31.**	B	**32.**	A
33.	B						

OLYMPIAD QUESTIONS

Q.1 A proton is identical to-

(A) the nucleus of helium

(B) the nucleus of a hydrogen atom

(C) a molecule of a hydrogen

(D) an atom of hydrogen

Q.2 An α-particle is-

(A) a hydrogen molecule

(B) a helium nucleus

(C) an electron

(D) a proton

Q.3 The atomic number of an element is determined by-

(A) the number of electrons in one atom
(B) the number of neutrons in one atom

(C) the valency of the element

(D) the number of protons in one atom

Q.4 The value of e/m of an electron was measured by-

(A) Millikan

(B) J.J. Thomson

(C) Dalton

(D) Rutherford

Q.5 The atomic number of an element is 11 and its mass number is 23. The respective number of electrons, protons and neutrons in this atom will be:

(A) 11, 11, 12

(B) 11, 12, 11

(C) 12, 11, 11

(D) 23, 11, 23

Q.6 The number of electrons in the outer shell of the most stable or inert atoms is:

(A) 1 (B) 4

(C) 6 (D) 8

Q.7 Which of the following pairs are isotopes?

(A) oxygen and ozone

(B) ice and steam

(C) nitric oxide and nitrogen dioxide
(D) hydrogen and deuterium

Q.8 An atom which has a mass number of 14 and has 8 neutrons is an:

(A) isotope of oxygen

(B) isobar of oxygen

(C) isotope of carbon

(D) isobar of carbon

Q.9 Which of the following has an equal number of neutrons and protons?

(A) hydrogen

(B) deuterium

(C) fluorine

(D) chlorine

Q.10 An atom of an element has 26 electrons atom contains _____ neutrons.

(A) 26 (B) 36

(C) 30 (D) 56

Q.11 For an element with atomic number 19, the 19th electron will occupy-

(A) L-shell

(B) M-shell

(C) N-shell

(D) K-shell

Q.12 Members of which of the following have similar chemical properties?

(A) isotope

(B) isobars

(C) allotropes

(D) both isotopes and allotropes

Q.13 The number of of electrons in an element with atomic number X and mass number Y will be-

(A) X – Y (B) Y – X

(C) X + Y (D) X

Q.14 A natural phenomenon that supports the experimental conclusion that atoms are divisible is-

(A) allotropy

(B) radioactivity

(C) cracking

(D) none of these

Q.15 The relative atomic masses of many elements are not whole numbers because-

(A) they cannot be determined very accurately
(B) the atoms ionize during the determinations

(C) of the existence of isotopes

(D) of the presence of impurities

Q.16 The valency of an element is-

(A) the mass of the element displacing 1 part by the mass of hydrogen

(B) the mass of the element combining with 8 parts by mass of oxygen

(C) the number of atoms of hydrogen combining with 1 atom of the given element

(D) the number of atoms in 1 molecule of the given element

Q.17 The absolute charge of the electron is.

(A) 1.1×10^{11}C

(B) 1.6×10^{14}C

(C) 1.6×10^{-19}

(D) 6.0×10^{21}C

Q.18 The fundamental particles not present in the nucleus of hydrogen atom is-

(A) electron (B) proton

(C) neutron (D) none of these

Q.19 The number of valence electrons present in Ca atom-

(A) 3 (B) 2

(C) 8 (D) 6

Q.20 The maximum number of electrons that can be accommodated in M Shell of an atom are-

(A) 8 (B) 32

(C) 18 (D) 25

ANSWER KEY

1.	D	**2.**	B	**3.**	D	**4.**	A
5.	A	**6.**	D	**7.**	D	**8.**	C
9.	B	**10.**	C	**11.**	B	**12.**	A
13.	D	**14.**	B	**15.**	C	**16.**	C
17.	C	**18.**	C	**19.**	B	**20.**	C

IIT-JEE QUESTIONS

1. The 'nuclear model' of atom was proposed by-
(A) Aston (B) Bohr (C) Chadwick (D) Rutherford

2. Which of the following species has no charege -
(A) Electron (B) Neutron (C) Nucleus (D) Proton

3. The nucleus of an atom contains -
(A) Neutrons and electron (B) Protons and electrons
(C) Protons and neutrons (D) Protons, neutrons and electrons

4. Neutrons were discovered by -
(A) Aston (B) Bohr (C) Chadwick (D) Rutherford

5. According to the nuclear model of atom -
(A) Electron and neutrons are present in the centre and protons are present in the outer space
(B) Electron and protons are present in the centre and neutrons are present in the outer space
(C) Protons and neutrons are present in the centre and electrons are present in the outer space
(D) Neutrons are present in the centre while protons and electrons are present in the outer space.

6. The element with the same atomic number and mass number is-
(A) Oxygen (B) Hydrogen (C) Helium (D) Carbon

7. The mass of an electron is -
(A) 1837 times of mass of proton (B) $1/1837^{th}$ times the mass of oxygen atom
(C) $1/1837^{th}$ times the mass of carbon atom (D) $1/1837^{th}$ times the mass of hydrogen atom

8. Neutrons were discovered by -
(A) Joseph Thomson (B) James Chadwick (C) Ernest Rutherford (D) John Dalton

9. The scientist who put forward the atomic theory in 1808 was
(A) Dalton (B) Lavoiser (C) Galileo (D) Thomson

10. The mass number of an element is the sum of the number of -
(A) Proton and electron (B) Electron and neutrons
(C) Protons, electrons and neutrons (D) Protons and neutrons

11. Rutherford directed a stream of .....on a thin Gold leaf in the scattering experiment-
(A) Alpha particle (B) Beta particle
(C) Gamma particle (D) X-rays

12. Atom is electrically neutral because -
(A) It contains neutrons
(B) It contains euqal number of protons and electrons
(C) The electrons are in a state of continuous motion around the nucleus
(D) The nuclues in the centre of the atom

13. The mass of an electron is-
(A) Equal to that of a neutron (B) Equal to that of proton
(C) Greater that of a proton (D) 1/1840 that of a proton

14. The mass of an electron is -
(A) 9.11×10^{-29}kg (B) 9.11×10^{-31}kg (C) 9.11×10^{-33}kg (D) 9.11×10^{-35}kg

15. A unit of charge is equal to -
(A) 1.602×10^{-19}C (B) 1.602×10^{-20}C (C) 1.602×10^{-21}C (D) 1.602×10^{-22}C

16. The sizes of a cation and the corresponding atom bear the following relationship-
(A) $r_{cation} > r_{atom}$
(B) $r_{cation} < r_{atom}$
(C) $r_{cation} = r_{atom}$

(D) r_{cation} may be greater than or smaller than or equal to r_{action} depending upon the nature of cation and atom

17. The sizes of an anion and the corresponding atom bear the following relationship-
(A) $r_{anion} > r_{atom}$
(B) $r_{anion} < r_{atom}$
(C) $r_{anion} = r_{atom}$
(D) r_{anion} may be greater than or smaller than or equal to r_{atom} depending upon the nature of cation and atom

18. In the nth electronic level, the number of orbitals is -
(A) n (B) 2n (C) n^2 (D) $2n^2+1$

19. Which of the following orbitals is not possible -
(A) 1s (B) 1p (C) 2p (D) 3d

20. Which of the following orbitals has larger energy -
(A) 2s (B) 2p (C) 1s (D) 3p

21. Which of the following orbitals has spherical shape-
(A) s (B) p (C) d (D) f

22. Atomic number of an element is denoted by -
(A) X (B) A (C) Z (D) N

23. In the periodic table, the elements are arranged in the -
(A) Increasing order of atomic mass (B) Decreasing order of atomic number
(C) Alphabetical order (D) Increasing order of atomic number

24. In a neutral atom, the number of proton is equal to -
(A) Number of electron (B) Half the number of electrons
(C) Number of neutrons (D) Number of electrons + number of protons

25. The mass number of an element is denoted by
(A) A (B) Z (C) X (D) N

26. The mass proton is about the same as that of -
(A) Carbon atom (B) An electron (C) Hydrogen ion (D) Oxygen atom

27. Mass of a neutron is equal to -
(A) The mass of an electron (B) Half of mass of an electron
(C) The mass of proton (D) Half of mass of a proton

28. The isotope possesss
(A) Similar physical properties (B) Similar chemical properties
(C) Different physical properties (D) Different chemical properties

29. Cathode rays are
(A) Alpha particles (B) Electrons (C) Neutrons (D) Protons

30. From the discharge tube experiment in which cathode rays are emitted, it is inferred that
(A) Mass of a proton is in fraction (B) matter contains electrons
(C) Nucleus is postively charged (D) Positive rays are heavier than protons

31. The flurescence on the wall of discharge tube is due to-
(A) Alpha rays (B) anode rays (C) Canal rays (D) Cathode rays

32. Which of the following shells can have a maximum number of 18 electrons
(A) K-shell (B) L-shell (C) M-shell (D) N-shell

33. Mass number of an element is equal to the
(A) Number of neutrons
(B) Number of protons
(C) Sum of the numbers of protons and neutrons in the nucleus

(D) Sum of the numbers of protons and electroons

34. Which of the following is not true for isotopes -
(A) They have the same atomic number (B) They have the same mass number
(C) They have the same electornic configuration
(D) The have the same chemical properties

35. In $^{24}_{12}Mg$, the number 24 represents -
(A) Atomic number (B) Mass number (C) Number of neutrons (D) Number of electrons

36. Which of the following properties of atoms of elements is definitely a whole number -
(A) Relative atomic mass (B) Atomic volume
(C) Atomic number (D) Atomic radius

37. Which of the following pairs provides an example of isobar
(A) $^{12}_{6}C$ and $^{14}_{6}C$ (B) $^{11}_{6}B$ and $^{11}_{5}B$ (C) $^{2}_{1}H$ and $^{3}_{1}H$ (D) $^{16}_{8}O$ and $^{18}_{8}O$

38. In the *n*th electronic level, the number of electrons is given by -
(A) n (B) 2n (C) $2n^2$ (D) $2n^2 + 1$

39. The mass number of helium nucleus is -
(A) 1 (B) 2 (C) 4 (D) 6

40. The number of electrons in $_{13}Al^{3+}$ is -
(A) 13 (B) 12 (C) 11 (D) 10

41. The approximate radii of the nuclei of atoms lie in the range of
(A) $10^{-14} - 10^{-15}$m (B) $10^{-12} - 10^{-11}$m (C) $10^{-11} - 10^{-10}$m (D) $10^{-28} - 10^{-29}$m

42. The approximate radii of atoms lie in the range of -
(A) 10^{-6}m – 10^{-5}m (B) 10^{-7}m – 10^{-6}m (C) 10^{-18}m – 10^{-17}m (D) 10^{-10}m – 10^{-9}m

43. Most favourable for electrovalency are-
(A) Low charge on ions, large cation and small anion
(B) High charge on ions, small cation and large anion
(C) High charge on ions, large cation and small anion
(D) Low charge on ions, small cation and large anion

44. When sodium chloride is dissolved in water, the sodium ion gets -
(A) Oxidised (B) Reduced (C) Hydrolysed (D) Hydrated

45. Which one of the following bonds will be the most polar-
(A) N–Cl (B) O – F (C) C – F (D) N – N

46. Rutherford α-particle scattering experiement eventually led to the conclusion that
(A) mass and energy are related (B) electrons occupy space around the nucleus
(C) neutrons are burried deep in the nucleus
(D) the point of impact with matter can be precisely determined.

47. Atomic number of an element is equal to the -
(A) Number of electrons in the atom (B) Number of nucleons in the atom
(C) Number of neutrons in the atom (D) Total number of elementary particle in the atom

48. Sodium atom differs from sodium ion in the number of -
(A) Electrons (B) Nucleons (C) Neutrons (D) Protons

49. Calcium atom and calcium ion differ in all of the following respects except-
(A) Net electrical charge (B) Number of electrons
(C) Number of protons (D) Radius

50. Neutrons is not present in -

(A) Helium (B) Deuterium (C) Protium (D) Tritium

51. Number of electron outside the nucleus of an atom is equal to the number of
(A) Neutrons in the nucleus (B) Protons in the nucleus
(C) Neutrons minus protons in the nucleus (D) Neutrons plus protons in the nucleus

52. Isotopes differ in their
(A) Chemical reactivity (B) Number of neutrons
(C) Number of protons (D) Valence electrons

53. The number of electrons in the atom which has 17 protons in the nucleus is -
(A) 10 (B) 17 (C) 34 (D) Not predictable

54. Which of the following is not true of isobars
(A) They have different mass number (B) They have different atomic number
(C) They have different number of protons
(D) They have different electronic configurations

55. $^{40}_{18}Ar$ and $^{40}_{20}Ca$ are referred to as -
(A) Isobars (B) Isotopes (C) Fission products (D) Nuclear isomers

56. Which of the following has more electrons than neutrons -
(A) Na^+ (B) Mg^{2+} (C) F^- (D) O^{2-}

57. In $^{7}_{3}Li$, the number 3 represents
(A) Atomic number (B) Relative atomic mass (C) Mass number (D) Number of neutrons

58. Which of the following sub-atomic particles are always present in the nuclei of atoms
(A) Electrons (B) Alpha particles (C) Positrons (D) Protons

59. Mass number of $^{35}_{17}Cl$ is-
(A) 17 (B) 35 (C) 35–17=18 (D) 35 + 17 = 52

60. Atomic number of $^{23}_{11}Na$ is-
(A) 11 (B) 23 (C) 23 – 11 = 12 (D) 23 + 11 = 34

Instruction :

The question from 61 to 63 consist of an Assertion (a) and Reason (r). Use the following key to choose the correct answer-
(A) If both (a) and (r) are correct and (r) is the correct explanation of (a)
(B) If both (a) and (r) are correct and (r) is not the correct explanation of (a)
(C) If (a) is correct but (r) is incorrect
(D) If (a) is incorrect but (r) is correct

61. (a) : In Rutherford gold foil experiment, very few α-particles are deflected black
(r) : Nucleus present inside the atom is heavy

62. (a) : Ionic compounds tend to be non-volatile.
(b) : Inter molecular forces in these compounds are weak

63. (a) The atom in a covalent molecule are said to share electrons, yet some are polar.
(r) : In polar covalent molecule, the shared electron spend more time on the average near one of the atoms.

64. Two atoms A and B are represented by their mass number and atomic number as

$^{19}_{9}A$ and $^{21}_{9}B$

Read the following statements :

(A) A and B belong to the same element (B) A and B have the same number of protons
(C) A and B are isotopes (D) A and B are isobars
(E) A and B have the same number of neutrons
Which one of the following groups of statement in correct-
(A) c, e, d (B) a, b, d (C) b, c, a (D) e, a, b

65. Mass number of oxygen is -
(A) 8 (B) 16 (C) 20 (D) 32

66. Which of the following species are isoelectronics-
(A) He and Ne (B) Cl^- and Br^- (C) Na^+ and Mg^{2+} (D) Mg^{2+} and Ca^{2+}

67. $^{37}_{17}C$ has
(A) 17 protons and 17 neutrons (B) 17 protons and 20 neutrons
(C) 17 protons and 37 neutrons (D) 37 protons and 17 neutrons

68. The addition of a nuetrons to the nucleus of an atoms result in -
(A) Increase in atomic number (B) Increase in mass number
(C) Increase in nuclear charge (D) Formation of an isobar

69. Na is the symbol of -
(A) Sulphur (B) Sodium (C) Potassium (D) None of these

70. The atomic and mass number of Helium are-
(A) 6, 12 (B) 7, 14 (C) 2, 4 (D) 15, 31

71. The symbol of phorphorus is -
(A) K (B) P (C) F (D) Fe

72. Atoms of same element having same atomic number but different mass number is called-
(A) Isotope (B) Isobar (C) Isoelectronic (D) None of these

73. Atomic number 6 and mass number 12 are of the element
(A) Hydrogen (B) Nitrogen (C) Carbon (D) Oxygen

74. $_1H, ^2_1H, ^3_1H$ are the .....of hydrogen
(A) Isotope (B) Isobar (C) Both isotope and isobar (D) Allotrops

75. Carbon has three isotopes, whose mass number are -
(A) 11, 12, 13 (B) 12, 13, 14 (C) 14, 15, 16 (D) 6, 7, 8

76. Atom of different element with different atomic number but same mass number are called.
(A) Allotropes (B) Isobar (C) Isotope (D) None of these

77. Protium, deuterium and tritium are the isotopes of -
(A) Nitrogen (B) Oxygen (C) Hydrogen (D) Carbon

78. Entire positive charge in an atom is concentrated in a small area at its centre called nucleus. This was suggested by -
(A) Thomson (B) Rutherford (C) Bohr (D) Dalton

79. Which is the correct order of orbital energy in a multi-electron atom
(A) 1s > 2s < 2p < 3s < 3p < 3d (B) 1s < 2s < 2p < 3s < 3p < 3d
(C) 1s > 2s < 3d < 2p < 3s < 3p (D) 1s > 2s < 2p < 3s < 3p < 3d

80. Which of the following configuration represents more electropositive atom ?
(A) $1s^2, 2s^2, 2p^2, 3s^2$ (B) $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$
(C) $1s^2, 2s^2, 2p^6, 3s^2, 3p^6$ (D) $1s^2, 2s^2, 2p^6, 3s^2, 3p^5$

ATOMIC STRUCTURE																				
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans	D	B	C	C	C	B	D	B	A	D	A	B	D	B	A	B	A	C	B	D
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans	A	C	D	A	A	C	C	B	B	B	D	C	C	B	B	C	B	C	C	D
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans	A	D	C	D	C	B	A	A	C	C	B	B	B	A	A	D	A	D	B	A
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans	B	C	C	C	B	C	B	B	B	C	B	A	C	A	B	B	C	B	B	B